Mental health before and during the COVID-19 pandemic: a longitudinal probability sample survey of the UK population

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Summary (248/250 words)

Background There is growing global concern about the potential impact of the COVID-19 pandemic on population mental health. We examine changes in adult mental health in the UK population before and during the lockdown.

Methods Secondary analysis of the UK Household Longitudinal Study Waves 6 (2014/15) to 9 (2018/19), matched to the COVID-19 web-survey completed by 17,452 panel members 23-29 April 2020. Mental health was assessed using the 12-item General Health Questionnaire (GHQ). Repeated cross-sectional analyses were conducted to examine temporal trends. Fixed effects regression models were fitted to identify within-person change compared to preceding trends.

Findings Population prevalence of clinically significant levels of mental distress rose from 18·9% (95% confidence interval: 17·8-20·0) in 2018/19 to 27·3% (26·3-28·2) in April 2020, one month into lockdown. Mean GHQ-12 score also increased over this time, from 11·5 (11·3–11·6) to 12·6 (12·5–12·8). This was 0·48 (0·07-0·90) points higher than expected when accounting for prior upward trends between 2014 and 2018. Comparing scores within-individuals, adjusting for time-trends and predictors of change, increases were greatest in 18-24-year-olds (2·69 points, 1·89-3·48), 25-34-year-olds (1·57, 0·96-2·18), women (0·92, 0·50-1·35), and people living with young children (1·45, 0·79-2·12). People employed before the pandemic also averaged a notable increase in GHQ-12 score (0·63; 0·20-1·06).

Interpretation By late April 2020, mental health in the UK had deteriorated compared to trends pre-COVID-19. Policy emphasising the needs of women, young people and those with preschool aged children are likely to play an important part in preventing future mental illness.

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Research in context

Evidence before this study: We searched PubMed and Google Scholar with the terms "mental*" or "psychiatr*" and "prevalence" and "COVID*" or "Coronavirus" for articles published between 1st January 2020 and 30th May 2020. Nearly all studies identified used a non-probability sample design, focused on specific population subgroups (like health professionals), relied on non-validated mental health measures, or had no comparable pre-pandemic baseline data. One study was identified, which found increased rates of psychological distress among US adults, with increases greatest among young people and women.

Added value of this study: This is the first dataset to allow the change in UK mental distress attributable to the COVID-19 pandemic to be discerned, adjusting for prior long-term trends and demographic, socioeconomic and health-related factors. The significant increase in mental distress in the UK population has not affected all groups equally. Established health inequalities persist, with prevalence of mental distress higher in people with pre-existing health conditions, living in low-income homes, and of Asian ethnicity. Other sources of inequalities have widened: with pronounced increases in younger (but not older) age groups, and in women (but not men). New inequalities in mental distress have emerged: those living with young children and those in employment at the start of the pandemic being at risk of larger increases in mental distress.

Implications of all the available evidence: While COVID-19 infection presents the greatest physical health risk to older people, the mental health of the young may be disproportionately affected by transmission mitigation strategies and the pandemic response of governments. Similarly, a greater increase in mental distress among women widens established mental health inequalities and highlights the importance of providers maintaining access to domestic violence, sexual and reproductive health services, and prioritising availability of childcare is an urgent need. Mental distress in men may be manifest differently, and this needs investigation. These results reflect the UK situation after one month in lockdown. As furloughs turn into redundancies and mortgage holidays time out, the socioeconomic fallout on mental health

inequalities will likely widen and deepen and must be monitored closely and mitigated against early.

Introduction

The COVID-19 virus, and measures taken to curb its spread, have had profound effects on almost every aspect of people's lives around the world. From 23rd March 2020, the UK government's 'lockdown' stipulated severe restrictions on social contact, on the ability for many people to work, and greatly reduced access to services. Early indications suggest that the impact on individuals' employment and livelihoods, income and personal debt will be immense.[1] Coupled with significant worry about future insecurity,[2] this has led to increasing concerns about the mental health sequelae of the pandemic in the UK.[3] Policymakers, commissioners and service providers need reliable information about mental health changes relevant to the pandemic so that decisions are underpinned by knowledge of the scale of changes in population mental health and who is most vulnerable.[4]

Evidence from around the world on change in population mental health potentially attributable to the COVID-19 pandemic has been limited by use of convenience samples, modified or non-validated mental health measures, and a lack of comparable, pre-COVID-19 baseline data against which to measure change; either within individuals or across the population as a whole.[5] One study found increased rates of psychological distress among US adults in April 2020 compared with 2018, and that the increase was greatest in young people and women[6].

Well-described demographic effects on mental health such as sex, age, and socioeconomic resources, as well as pre-pandemic life circumstances, are likely to remain important determinants of people's mental health during pandemic.[7] However, change in mental health during the public health emergency may not be evenly distributed across the population.[8] Effects specific to lockdown include acute financial strain (low income, unemployment) and household dynamics (domestic violence, living alone or with young children not attending nursery or school),[9] as well as exposures like having an underlying mental or physical

health condition or being a keyworker exposed to potential infection.[10] For some people, with high levels of socioeconomic security, the suspension of commuting, changes to education and work activities, and increased time with family potentially could have reduced stress and increased mental health and wellbeing. For others, anxieties about infection risk may be particularly high.[11] The World Health Organization (WHO) has highlighted concerns for older adults, especially in isolation, and those with cognitive decline/dementia, who may become more anxious, angry, stressed, agitated or withdrawn during the outbreak or whilst in quarantine.[12]

We used a national longitudinal cohort to test the hypothesis that psychological distress in people in the UK increased one month into the COVID-19 emergency compared to prior trends. We also hypothesised that the following groups would experience greater than expected deterioration in their mental health: younger and older people, women, ethnic minorities, those living without a partner and/or with children, keyworkers, those living in the poorest homes or unemployed, people in urban areas or regions first affected by COVID-19, and those with pre-existing health conditions.

Methods

Study design and participants

The UK Household Longitudinal Study (UKHLS) is an ongoing panel survey of over 40,000 households that started in 2009.[13,14] From 23rd to 28th April 2020, UKHLS panel members that took part in either of the two most recent data collections (Wave 8 or 9) were invited to complete the first wave of the COVID-19 web-survey.[15,16] Invitations and reminders were sent via email, text message, and/or postal letter. The probability sample was drawn from postal addresses. In England, Wales and Scotland, they were clustered and stratified; in Northern Ireland un-clustered systematic random samples were drawn. Northern Ireland and areas in England, Scotland and Wales with proportionately large migrant and ethnic minority populations were oversampled. All household members aged 16 or above in April 2020 were invited to participate, except for

those unable to make an informed decision as a result of incapacity, and those with unknown postal addresses or addresses abroad.

Web-survey interviews were completed (full and partial) by 15,835 of the 32,596 Wave 9 participants, representing a response rate of 48·6%. When also including those who took part in Wave 8 (but not Wave 9), 17,452 participated out of the total sample of 42,330, a 41·2% response rate (see Figure 1).

Pre-COVID-19 measures were extracted from participants aged 16 and over in Waves 6 to 9 (N = 53,351) and participants were linked across waves. Prior waves were carried out annually from 1st January 2014, with most of the fieldwork taking place over the course of two years. Thus, waves overlap in their data collection periods (e.g. Wave 6: 1st January 2014 to 31st December 2015; Wave 7: 1st January 2015 to 31st December 2016). Data from prior waves were mainly collected via face-to-face interviews.

Outcome measures

Mental distress: The 12-item General Health Questionnaire (GHQ-12) is a validated measure of non-specific mental distress in the past two weeks, which performs well in longitudinal samples.[17] It was administered by self-completion in Waves 6–9 and as part of the COVID-19 web-survey and covers symptoms such as difficulties with sleep, concentration, problems in decision making, strain and feeling overwhelmed.

We examined two GHQ-12 measures in the analyses: a mean symptom score (indicating a central average for the population) and a binary 'threshold' score (indicating the proportion of the population with a clinically significant level of distress). For the mean, GHQ-12 items were scored: 'not at all' (0), 'no more than usual' (1), 'rather more than usual' (2), or 'much more than usual' (3), and a total score was derived for each wave (0-36). The threshold measure was derived by scoring responses 'not at all' and 'no more than usual' as 0 and 'rather more than usual' and 'much more than usual' as 1, summed to produce a total (range 0-12). The cut-off for the threshold measure was a score of 4 or more, as used on the Health Survey for England Official Statistics indicator.[18]

Covariates

Demographic variables were extracted on sex (women/men); age (16-24, 25-34, 35-44, 45-54, 55-69, 70+); ethnicity (White British, White non-British, Mixed, Asian, Black, Other); and geography (Wales, Scotland, Northern Ireland, and region of England). An indicator of urbanity, based on population density, and classified as urban or rural, was extracted.

Socioeconomic variables were extracted from Waves 6-9 and analysed as lagged variables (i.e. using data collected from the previous wave) to ensure temporal ordering. Total annual household income was estimated with the use of a prompt card and scaled according to the number and ages of people living in the household using a weight of 1 for the first adult in the household; 0.5 for each additional person aged 14 or older; and 0·3 for each person aged 0-13. This measure of equivalised household income for each wave's sample was divided into quintiles for analysis. Employment status was categorised as: employed, unemployed, retired, and 'other economically inactive' (i.e. those not working and not looking for work, such as students, people unable to work for reasons of health or disability and carers).

Two aspects of the household structure were derived to identify whether the participant lived with a partner (yes/no) and the age of the youngest child living in the household (none; 0-5 years; 6-15 years).

Two further covariates collected during the COVID-19 web-survey were examine. First, those who reported receipt of a letter from the NHS or Chief Medical Officer indicating that they had been identified as someone at risk of severe illness should they contract coronavirus, because they had an underlying disease or health condition; second, participants who reported being a 'key worker' working in health or social care during the COVID-19 emergency.

Statistical analysis

Three stages of analyses were conducted. The first describes the COVID-19 web-survey sample participants and their mental health, overall and by subgroup.

The second used repeated cross-sectional analyses to produce temporal trends in mean GHQ-12 score and prevalence in the population for people exceeding threshold GHQ-12 scores. These analyses were conducted on data pertaining to all participants aged 16 and over. Mean GHQ-12 scores and prevalence were calculated according to UK financial year of the interview, grouping individuals across waves. Financial year (1st April to 31st March) was preferred over calendar year because data collection for Wave 9 only had a small fraction of observations in 2019 and estimates within this group would therefore be imprecise. Due to the small number of observations leading to less precise estimates, we excluded years 2019/20 (N=75 responses) and 2013/2014 (N=5,790). Mean scores and prevalence values were presented graphically as point estimates at the mid-point of each financial year (1st October) and estimates from the COVID-19 web-survey were presented at the midpoint of data collection (25th April 2020). Estimates were produced for the whole population, and by combinations of sex and age-group stratifications.

The third analysis examined the impact of the pandemic on changes within an individual's mental health using fixed effects regression. These models, therefore, included only those who participated in the COVID-19 survey and who had responded to at least one prior survey (N = 16,925). This means that, in this analysis, individuals aged 16 or 17 during the COVID-19 survey were not included as they would have no prior measurements against which to assess change over time. An indicator variable for GHQ-12 score during the COVID-19 emergency was constructed and fitted in a model with variables for calendar date of interview, parameterised as the number of years since the day of data collection, and included as a continuous variable and its squared term. Mean scores were used for the outcome measure, rather than fitting a fixed effects model for a binary outcome indicator. The latter approach would further reduce the sample available for analysis because it would exclude those who had concordant responses over follow-up, impacting on the statistical power and generalisability of the findings. The date variables captured time trends. A positive coefficient from the fixed effects model indicates worsening mental distress associated with the COVID-19 pandemic and takes account of any existing trends in psychological distress that were already occurring over time. Interactions between the COVID-19 period indicator and pre-defined subgroups

were fitted to investigate heterogeneity in the pandemic's impact. Effect estimates are also reported by subgroup and the associated p-values test the null hypothesis that there is no evidence for a difference in change associated with the pandemic between different subgroups of people. All statistically significant interactions ($p<0{\cdot}05$; two-sided) were included in a final model to investigate which had an independent influence. The adjusted coefficients are interpretable as the change within a subgroup, accounting for changes in overlapping subgroups. This adjustment enables elucidation as to whether a change in urban areas, for instance, can be explained by a greater proportion of people living in such localities also being of lower socioeconomic position. All covariates had less than 1% missing data except for the GHQ-12 scores, which were positioned at the end of the web-survey, and which were missing for 4·2% of respondents. Those with missing values for variables were excluded from analysis.

Analyses were carried out in Stata v14 and graphs were produced using the R package *ggplot*. To take account of the weighting and the clustered and stratified design, the *svy* suite of commands was used. Cross-sectional weights were used for cross-sectional analysis of Wave 6-9, and for the longitudinal analysis, a weighting variable was used that adjusted for unequal selection probabilities and differential nonresponse to the COVID-19 web survey. As of May 2020, this weight was released as a beta-version and slight future refinement of the weighting models are possible, but unlikely to have a significant impact on results.[15]

A sensitivity analysis was conducted to check potential seasonality effects, given that pre-COVID-19 data were collected year-round, whereas the COVID-19 web survey was carried out during late April. For this analysis, the fixed effect analysis was re-run on data pertaining to participants who had prior responses that fell in spring or summer months (N =9,294).

This study was unfunded. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication. The study protocol was pre-registered prior to any outcome data analysis (https://osf.io/mtr2z).

Results

The COVID-19 web-survey sample comprised 17,452 participants, aged 16 and over, weighted to be representative of the UK population (Table 1), with longitudinal analyses based on those aged 18 and over (median follow-up 5.3 years, IQR 4.6-5.8). This represents 41% of the available sample (figure 1). Characteristics associated with non-response to the web-survey are provided in the appendix (page 1).

Between 23rd and 28th April 2020, the mean GHQ-12 symptom score for the population was 12·6 (95% CI 12·5–12·8), with 27·3% (26·4–28·2%) exceeding the threshold score indicative of a clinically significant level of mental distress (Table 1).

Mean scores were higher for women (13·6, 13·4–13·8) than men (11·5, 11·3–11·7); and in younger age groups (16-24-year olds: 14·7, 14·1–15·3) than older ones (70 and over: 10·9, 10·6–11·1). Asian people had a higher mean score (13·7, 13·0–14·5) than White British (12·5, 12·4–12·7), although variation by other ethnic groups did not reach significance. Mean scores were also higher in London (13·3, 12·8–13·8) and among urban populations (12·8; 12·6–13·0) compared to rural (12·2, 11·9–12·4).

Socioeconomic patterns were notable. Mean scores were 13·9 (13·4-14·3) among those in households in the lowest income quintile and 12·0 (11·7-12·2) in the highest income homes. People who were unemployed (15·0, 14·0–15·9) or economically inactive (15·3, 14·8–15·9) had higher scores than those in employment (12·5, 12·3-12·7) or retired (11·1, 10·9–11·3). Key workers had a similar mean (average) score to the rest of the population, but were more likely to exceed the clinically significant threshold score.

People not cohabiting with a partner (13·8, 13·6–14·1) or with young children in the household (13·7, 13·2–14·3) also had higher scores; as did those who received a 'shielding' letter from the government because of a pre-existing health condition (13·7, 13·1–14·3).

Between 23rd and 28th April 2020, the mean score for the overall population was 12·6 (95% CI 12·5–12·8); higher than the mean scores in 2018/19 (11·5, 11·3–11·6), 2017/18 (11·4, 11·3–11·4) and for earlier waves (Table 2). The increases were significant in both women and men overall and in each age group. Increases were steepest for women aged 16 to 44, and men aged 16 to 24 (appendix page 4).

During late April 2020 over a quarter (27·3%; 95% CI 26·3–28·2) of the population reported a GHQ-12 score that indicated a clinically significant level of mental distress. Whilst a steady upward trend had already been evident over recent years (from 16·7% [16·1-17·3] in 2014/15 to 18·9% [17·8-20·0] in 2018/19), a marked step-change increase occurred in 2020 (appendix page 5). There were particularly steep increases evident in young people and in women; for instance, 44·0% of women aged 16-24 (95% CI 39·2–48·9) reported clinically significant distress in April 2020, compared to 32·0% (27·5–36·5) in 2017/18.

Table 3 presents the results of the fixed effects regression analyses. Overall, GHQ-12 scores were 0·48 (0·07–0·90) points greater than would have been expected had trends observed in the years before the COVID-19 pandemic continued. There was clear evidence, after adjustment, for heterogeneous effects by age and sex (both effect modifiers: $p < 0·0001$). The mean score in 18-24-year olds was 2·69 (1·89–3·48) points higher than would have been expected from the trends prior to the pandemic. Adjusted estimates indicated that women experienced an increase of 0·92 (0·50–1·35) points, whereas there was no evidence of higher than expected scores for men (0·06, -0·37 to 0·48). Living with children in the house significantly modified the effect ($p=0·0032$): those with children aged under 5 had a 1·45 (0·79–2·12) point increase in GHQ-12 score after adjustment for other factors. Being either in employment (0·81, 0·38–1·24), or retirement (0·93, 0·42-1·44) before the pandemic was also associated with a greater increase in scores after adjustment. There was evidence of variation in score increase by household income ($p=0·00079$), although no clear trend was discernible. Other characteristics tested (ethnicity, urbanicity, living with a partner, having an underlying health condition and being a health or social care key worker) did not independently predict differences in

effect. In the sensitivity analysis that restricted prior data to spring/summer months (1st April to 31st August) the overall change associated with the COVID-19 emergency increased to 1·13 (0·39-1·86).

Discussion

This is among the first national probability sample studies to track temporal changes in population mental health from before the COVID-19 pandemic and into the subsequent lockdown period. Consistent with our hypothesis, we found an overall increase in mental distress in people aged 16 or more in the UK compared to the previous year: mean population GHQ-12 score increased from 11·5 (11·3–11·6) in 2018/19 to 12·6 (12·5–12·8) between 23rd and 28th April 2020. This increase in population mental distress was not simply a continuation of prior upward trends: we estimate that the average score was 0·48 points higher than would have been expected had trajectories from 2014-2019 continued.

This higher than projected increase in mental distress did not affect all groups equally, with people in some demographic subgroups apparently experiencing little (or no) additional mental distress after lockdown, whilst other subgroups evidenced marked increases. The factors that we hypothesised would be most strongly linked with mental health deterioration were those associated with pre-existing health inequalities, such as sex, age and low income, and factors specific to the unique circumstances of societal lockdown such as household dynamics, being a keyworker, and having a pre-existing health condition. Our findings suggest that being young, a woman, and living with children, especially pre-school age children, have had a particularly strong influence on the extent to which mental distress increased one month into lockdown. Whilst rates of mental distress were higher in people who, before lockdown, were unemployed or in other economically inactive roles such as being a full-time student, the *increase* in mental distress relative to prior trends was greater among those who were employed before the pandemic. Some in this group will have just lost their jobs, seen their income levels plummet, been furloughed, attempted to shift to homeworking, or been required to work in ways that exposed them to COVID-19

infection. At this early stage (late April), we found no clear pattern of variation in change by income group. However, consistent with established patterns, mental distress was more common among people living in low income households.

Contrary to our hypothesis, we did not find a significant additional independent increase in an individual's change in mental distress due to the COVID-19 pandemic according to other pre-existing characteristics. These included being an ethnic minority, living without a partner, being a keyworker, being unemployed, living in an urban area, or having a pre-existing health condition that would put a person at greater risk from infection with COVID-19. For these categories, established pre-pandemic inequalities in mental health were maintained, but they had apparently not significantly increased by the end of the first month of the lockdown period.

This is one of the first national general population probability sample studies to emerge using a reliable measure of mental health with pre-pandemic baseline data enabling the long-term tracking of population mental health before and during COVID-19. It identifies which individuals before the pandemic were at greatest risk of subsequent increases in mental distress. However, whilst the UKHLS is a high-quality probability sample cohort study, response to the COVID-19 wave questionnaire was less than 50%, and varied by age, sex, ethnic group, health status, and other characteristics (see appendix page 1). Although non-response was adjusted for via application of survey weights, attrition remains a potential source of bias.

The GHQ-12 is a screening tool and, although it correlates strongly with presence of mental illness as well as future clinical diagnosis of psychiatric disorder and a high score threshold was applied (four or more) for the analysis of prevalence, it is not a clinical assessment. This means that, for example, the notable proportion (44%) of women aged 16-24 (95% CI 39·2–48·9) who reported clinically significant scores during April 2020 should be interpreted with caution and does not necessarily imply that nearly half of young women in the population require treatment for a mental illness. The GHQ-12 underestimates both socioeconomic and ethnic disparities.[20] Further, mental distress in men may be more likely to manifest in ways not captured by the GHQ-12, including alcohol misuse.

While the sample was large, it was underpowered to detect change for some groups. Specifically, a major limitation was the lack of scope to examine significant change by different ethnic groups, and for men and women separately within ethnic groups, in particular given the high prevalence of mental distress evident in the descriptive analysis. We found some evidence in mean scores of widening inequalities for both ethnic minorities and those in lowest income quintiles. However, within-person adjusted analyses did not find significant effects for these characteristics.

Between Wave 9 and the COVID-19 survey, necessary changes were introduced in the mode of the questionnaire administration which could have effected reporting: in Wave 9 the GHQ-12 was self-completed with the interviewer present as part of a face-to-face interview, whereas the COVID-19 questionnaire was completed online. Future data collection by telephone with those unable or unwilling to complete online will be forthcoming, but these data were not yet available for this analysis and this could have introduced bias. Finally, no contemporaneous control group was available so we cannot rule out secular changes, aside from those predicted from prior data, that would have occurred anyway. Therefore, we cannot unequivocally rule out other ecological drivers of change in mental health that might have influenced our results. However, given the acute nature and degree of change it is likely that the changes that we have in population mental health are largely attributable to the virus and events associated with the pandemic.

The initial increase in mental distress in the UK population one month after lockdown may represent a 'spike' in emotional response that stabilises or reduces as people adjust; a phenomenon already described in several non-probability surveys.[21–23] Opposite trends may also develop as differences in people's reactions to crisis become apparent.

Certain groups experienced higher mental distress than others, indicating persistence of ethnic and socioeconomic health inequalities. Some experienced higher than expected increases in mental distress; and this served widen pre-existing age and sex inequalities. However some inequalities reduced for example because those in employment pre-pandemic experienced a marked deterioration in their mental health. Although we did not see above average

increases in mental distress associated with poverty, our findings do suggest that overall pre-existing inequalities in mental health have widened.

This study identifies groups in the population who, pre-pandemic, already had raised prevalence of psychological distress. As the economic consequences of lockdown develop, when furloughs turn to redundancies, mortgage holidays time-out, and recession takes effect, we anticipate not only sustained distress and clinically-significant deterioration in mental health for a few, but emergence of well-described long-term effects of economic recession on mental health including increasing suicide rates[24] and hospital admissions[25] for mental illness.[26]

Women, young people, and those with preschool aged children are experiencing the greatest increase in mental distress. This mirrors previous reports of high prevalence of common mental disorder and self-harm in girls and women aged 16-24 (McManus et0020al 2016; 2019; Sadler et al);[7,27–29] while Marmot (2020) has made a pressing case for tackling health inequalities for women in poverty.[30] The COVID-19 pandemic has produced many new challenges for health research, policy and service provision.[3] The problems for mental health from COVID-19, and governmental responses to it may emerge as less novel; instead, pre-existing mental health inequalities may become more entrenched and tackling them may be even more challenging. The pandemic has brought people's differing life circumstances into stark contrast: access to outside and inside space, household crowding, lack of school provision and childcare, food insecurity, domestic violence, addiction, access to internet and maintenance of social connectivity, as well as economic reserves are all relevant to mental health.[9,10,31,32] An appropriate, proportionate response to mitigate and manage additional needs requires more high quality information to be included in public health messaging about mental health across the pandemic, alongside adequately resourced services.[12,33]

Contributors

KMA and SM conceived of the study. MP wrote the initial analysis plan with input from all authors. MP carried out data analysis and produced figures. KMA, MP and SM wrote the first draft of the manuscript and all authors contributed to editing and commenting on the final version.

Declaration of interests

The authors declare no competing interests.

Data sharing

The data used are publicly available via UK Data Service repository (study numbers 6614 and 8644), and do not require ethical assessment for academic research purposes.

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Table 1: COVID-19 web-survey sample profile and GHQ-12 responses N=17,452)

	Sample size	**Unweighted profile**	**Weighted profile**	**Mean GHQ-12 score**	**Significant level of mental distress***
	N	%	%	Mean [95% CI]	% [95% CI]
Total sample	17,452	100	100	12·6 [12·5, 12·8]	27·3 [26·4, 28·2]
Sex					
Women	10,165	41·8	46·7	13·6 [13·4, 13·8]	33·3 [32·1, 34·6]
Men	7,287	58·4	53·3	11·5 [11·3, 11·7]	20·4 [19·1, 21·6]
Age, years					
16-24	1,543	8·8	9·8	14·7 [14·1, 15·3]	36·7 [33·0, 40·4]
25-34	1,950	11·2	13·0	14·2 [13·7, 14·7]	35·0 [32·0, 38·0]
35-44	2,784	16·0	15·4	13·4 [13·0, 13·8]	30·6 [28·3, 32·9]
45-54	3,506	20·1	18·1	12·5 [12·2, 12·8]	26·3 [24·3, 28·2]
55-69	5,036	28·9	27·6	12·0 [11·8, 12·3]	24·7 [23·2, 26·2]
>=70	2,633	15·1	16·2	10·9 [10·6, 11·1]	17·6 [15·8, 19·5]
Ethnicity					
White British	14,029	80·4	86·9	12·5 [12·4, 12·7]	27·2 [26·3, 28·2]
White non-British	779	4·5	4·2	13·1 [12·3, 14·0]	27·5 [23·0, 32·0]
Mixed	284	1·6	1·3	13·7 [12·2, 15·2]	28·1 [20·2, 36·0]
Asian	1,281	7·3	4·4	13·7 [13·0, 14·5]	29·6 [25·2, 34·1]
Black	392	2·2	1·8	12·7 [11·5, 13·9]	21·3 [14·6, 28·0]
Other	87	0·5	0·5	13·7 [11·6, 15·7]	29·3 [13·2, 45·3]
Missing	600	3·4	1·0		
UK country/region					
North East	593	3·4	4·1	12·9 [12·2, 13·7]	28·9 [23·9, 33·8]
North West	1,716	9·8	11·1	12·1 [11·7, 12·5]	25·5 [22·8, 28·1]
Yorkshire	1,482	8·5	8·6	12·5 [12·1, 13·0]	25·8 [22·9, 28·7]
East Midlands	1,334	7·6	7·9	12·6 [12·1, 13·2]	27·2 [24·1, 30·3]
West Midlands	1,479	8·5	8·9	12·8 [12·3, 13·3]	29·5 [26·1, 32·9]
East of England	1,689	9·7	10·2	12·3 [11·8, 12·7]	24·9 [21·9, 27·9]
London	1,849	10·6	10·9	13·3 [12·8, 13·8]	29·3 [26·4, 32·1]
South East	2,428	13·9	14·5	12·5 [12·1, 12·9]	26·2 [23·8, 28·6]
South West	1,598	9·2	9·3	12·5 [12·0, 13·0]	28·1 [25·2, 31·0]
Wales	1,018	5·8	4·6	13·1 [12·4, 13·9]	28·3 [24·0, 32·7]
Scotland	1,523	8·7	7·8	12·9 [12·4, 13·3]	28·6 [25·5, 31·7]

Northern Ireland	742	4·3	2·3	12·5 [11·5, 13·5]	28·5 [23·1, 34·0]
Urbancity**					
Urban	12,623	74·6	75·1	12·8 [12·6, 13·0]	28·0 [26·9, 29·1]
Rural	4,291	25·4	24·9	12·2 [11·9, 12·4]	25·1 [23·3, 26·8]
Equivalised household income quintiles**					
Lowest	2,220	12·7	14·3	13·9 [13·4, 14·3]	32·3 [29·5, 35·2]
2nd	2,692	15·4	18·1	12·8 [12·4, 13·1]	25·7 [23·5, 27·9]
3rd	3,230	18·5	19·8	13·0 [12·6, 13·3]	29·3 [27·1, 31·5]
4th	3,995	22·9	22·1	12·1 [11·8, 12·4]	25·2 [23·3, 27·0]
Highest	4,449	25·5	23·0	12·0 [11·7, 12·2]	25·7 [24·0, 27·4]
Missing	866	5·0	2·7		
Employment status**					
Employed	10,636	60·9	61·1	12·5 [12·3, 12·7]	27·1 [25·9, 28·2]
Unemployed	446	2·6	3·4	15·0 [14·0, 15·9]	33·7 [27·5, 39·9]
Retired	3,770	21·6	21·6	11·1 [10·9, 11·3]	19·3 [17·7, 20·9]
Other inactive	2,062	11·8	13·8	15·3 [14·8, 15·9]	39·1 [36·2, 42·1]
Missing	538	3·1	0·1	12·5 [12·3, 12·7]	27·1 [25·9, 28·2]
Lives with partner					
Yes	12,316	70·6	66·0	12·0 [11·9, 12·2]	24·3 [23·2, 25·3]
No	5,136	29·4	34·0	13·8 [13·6, 14·1]	33·1 [31·3, 34·9]
Age of youngest child in household					
No children	12,221	70·0	72·2	12·3 [12·2, 12·5]	25·9 [24·8, 27·0]
0-5 years	1,756	10·1	9·0	13·7 [13·2, 14·3]	31·9 [28·7, 35·1]
6-15 years	3,475	19·9	18·8	13·4 [13·0, 13·7]	30·3 [28·1, 32·5]
Keyworker					
Yes	4,515	25·9	74·3	12·7 [12·4, 12·9]	29·9 [28·2, 31·7]
No	12,928	74·1	25·7	12·6 [12·4, 12·8]	26·4 [25·3, 27·4]
Missing	9	0·1	0		
Received NHS shielding letter					
Yes	1,007	5·8	6·6	13·7 [13·1, 14·3]	31·9 [27·9, 35·8]
No	16,439	94·2	93·4	12·6 [12·4, 12·7]	27·0 [26·0, 27·9]
Missing	6	0·0			

Sample sizes are true (unweighted). All analyses are weighted, adjusting for complex survey design & non-response. *GHQ-12 scores exceeding threshold indicative of a potentially clinically significant level of mental distress (4 or more).**Measured at prior wave.

Table 2: Mean GHQ-12 score and prevalence of clinically significant level of mental distress, overall and by age and sex, by year* (N= 53,314)

	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019	Apr-20
N	26,979	44,024	39,984	33,540	12,312	17,452
Mean GHQ-12 total						
Total	10·9 [10·8, 10·9]	10·9 [10·8, 10·9]	11·1 [11·1, 11·2]	11·4 [11·3, 11·4]	11·5 [11·3, 11·6]	12·6 [12·5, 12·8]
Sex						
Women	11·4 [11·3, 11·5]	11·4 [11·3, 11·5]	11·7 [11·6, 11·8]	11·9 [11·8, 12·1]	12·0 [11·8, 12·2]	13·6 [13·4, 13·8]
Men	10·3 [10·2, 10·4]	10·3 [10·2, 10·4]	10·6 [10·5, 10·7]	10·7 [10·6, 10·8]	10·8 [10·6, 11·1]	11·5 [11·3, 11·7]
Age, years						
16-24	10·9 [10·6, 11·1]	10·8 [10·6, 11·0]	11·1 [10·8, 11·3]	11·6 [11·3, 11·8]	12·0 [11·6, 12·5]	14·7 [14·1, 15·3]
25-34	11·0 [10·7, 11·2]	11·0 [10·8, 11·2]	11·4 [11·2, 11·6]	11·9 [11·6, 12·2]	12·1 [11·5, 12·6]	14·2 [13·7, 14·7]
35-44	11·2 [11·0, 11·4]	11·2 [11·0, 11·4]	11·4 [11·2, 11·6]	11·7 [11·4, 11·9]	11·7 [11·3, 12·1]	13·4 [13·0, 13·8]
45-54	11·3 [11·1, 11·5]	11·4 [11·2, 11·5]	11·7 [11·5, 11·8]	11·9 [11·7, 12·1]	12·0 [11·6, 12·4]	12·5 [12·2, 12·8]
55-69	10·6 [10·5, 10·8]	10·7 [10·6, 10·8]	11·0 [10·8, 11·1]	11·2 [11·0, 11·3]	11·2 [10·9, 11·5]	12·0 [11·8, 12·3]
>=70	10·2 [10·0, 10·4]	10·2 [10·0, 10·3]	10·4 [10·3, 10·6]	10·2 [10·1, 10·4]	10·1 [9·8, 10·3]	10·9 [10·6, 11·1]
Proportion with significant level of mental distress						
Total	16·7 [16·1, 17·3]	16·9 [16·4, 17·4]	18·2 [17·7, 18·8]	19·0 [18·4, 19·6]	18·9 [17·8, 20·0]	27·3 [26·3, 28·2]
Sex						
Women	19·4 [18·7, 20·2]	19·8 [19·1, 20·5]	21·0 [20·3, 21·7]	22·4 [21·6, 23·3]	23·0 [21·5, 24·5]	33·3 [32·0, 34·6]
Men	13·7 [12·9, 14·5]	13·8 [13·1, 14·4]	15·2 [14·5, 15·9]	15·3 [14·5, 16·1]	14·5 [13·0, 16·0]	20·4 [19·1, 21·7]
Age, years						

16-24	19·8 [18·0, 21·6]	19·6 [18·2, 21·0]	19·7 [18·2, 21·3]	23·5 [21·7, 25·3]	24·5 [21·3, 27·8]	36·7 [32·9, 40·5]
25-34	18·1 [16·4, 19·8]	18·3 [16·8, 19·7]	20·5 [18·9, 22·2]	21·7 [19·7, 23·6]	21·6 [18·1, 25·1]	35·0 [31·9, 38·2]
35-44	18·3 [16·8, 19·8]	18·1 [16·9, 19·4]	19·2 [17·9, 20·5]	19·9 [18·3, 21·5]	21·0 [18·4, 23·7]	30·6 [28·2, 33·0]
45-54	18·3 [17·0, 19·6]	18·8 [17·7, 19·9]	20·0 [18·8, 21·2]	20·5 [19·1, 21·9]	21·5 [18·9, 24·0]	26·3 [24·3, 28·2]
55-69	14·8 [13·8, 15·8]	15·2 [14·3, 16·1]	16·5 [15·6, 17·5]	17·7 [16·6, 18·8]	17·0 [15·1, 18·8]	24·7 [23·2, 26·3]
>=70	12·9 [11·7, 14·1]	12·8 [11·8, 13·8]	14·6 [13·5, 15·7]	12·9 [11·8, 14·0]	10·8 [9·1, 12·4]	17·6 [15·7, 19·5]

Sample sizes are true (unweighted). All analyses are weighted, adjusting for complex survey design & non-response.

*Based on financial year: April to March

Table 3: Fixed effects regression showing the within-person change in GHQ-12 score associated with the pandemic over and above the trends observed in prior waves (N=15,376)

	Unadjusted			Adjusted*		
	Change in GHQ-12 score	95% CI	p-value**	Change in GHQ-12 score	95% CI	p-value**
Total	0·48	0·07, 0·90				
Sex			<0·0001			<0·0001
Women	0·88	0·45, 1·31		0·92	0·50, 1·35	
Men	0·03	-0·40, 0·45		0·06	-0·37, 0·48	
Age, years			<0·0001			<0·0001
18-24	2·21	1·51, 2·91		2·69	1·89, 3·48	
25-34	1·61	1·01, 2·21		1·57	0·96, 2·18	
35-44	0·78	0·25, 1·31		0·53	-0·03, 1·10	
45-54	0·04	-0·44, 0·52		0·08	-0·41, 0·58	
55-69	-0·21	-0·66, 0·23		-0·02	-0·47, 0·43	
>=70	0·05	-0·39, 0·49		0·17	-0·33, 0·68	
Ethnicity			0·35	-		
White British	0·47	0·06, 0·89				
Non-white-British	0·71	0·10, 1·33				
Urbanicity			0·29	-		
Urban	0·52	0·10, 0·95				
Rural	0·37	-0·07, 0·82				
Equivalised household income quintiles***			0·025			0·00079
Lowest	0·63	0·07, 1·20		0·68	0·12, 1·25	
2nd	0·37	-0·14, 0·87		0·29	-0·21, 0·79	
3rd	0·56	0·08, 1·04		0·45	-0·03, 0·93	

4th	0·28	-0·19, 0·74		0·26	-0·20, 0·73	
Highest	0·80	0·36, 1·25		0·90	0·45, 1·35	
Employment status***			<0·0001			0·0037
Employed	0·63	0·21, 1·06		0·63	0·20, 1·06	
Unemployed	-0·07	-1·12, 0·97		-0·48	-1·55, 0·60	
Retired	0·07	-0·36, 0·51		0·73	0·24, 1·21	
Other inactive	0·68	0·10, 1·26		-0·19	-0·80, 0·43	
Lives with a partner			0·0021			0·48
Yes	0·33	-0·09, 0·75		0·60	0·13, 1·06	
No	0·78	0·32, 1·25		0·48	0·06, 0·90	
Age of youngest child in household			<0·0001			0·00032
No children	0·27	-0·15, 0·69		0·33	-0·09, 0·75	
0-5 years	1·73	1·11, 2·35		1·45	0·79, 2·12	
6-15 years	0·74	0·24, 1·25		0·81	0·28, 1·34	
Keyworker			0·80	-		
Yes	0·46	0·00, 0·92				
No	0·50	0·08, 0·91				
Underlying health conditions			0·050			0·66
Yes	-0·03	-0·72, 0·66		0·40	-0·30, 1·09	
No	0·53	0·12, 0·95		0·53	0·12, 0·94	

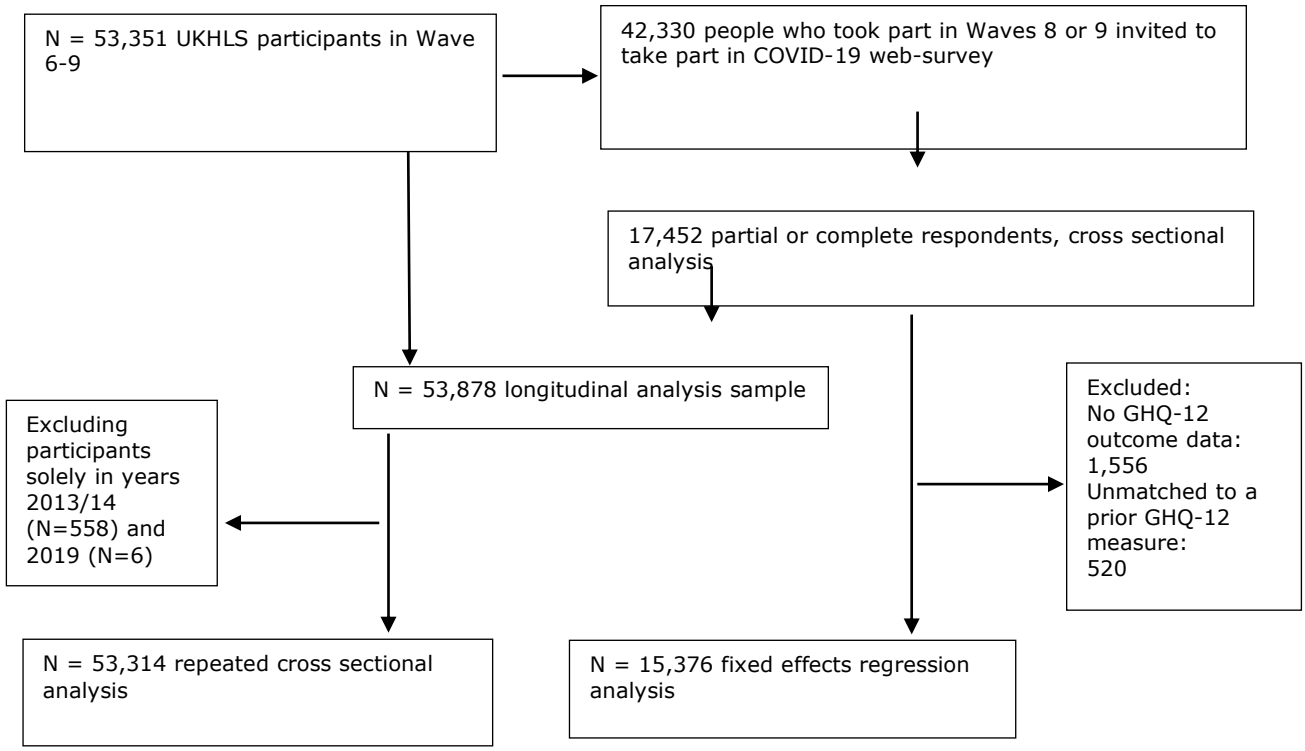
Sample sizes are true (unweighted). All analyses are weighted, adjusting for complex survey design and non-response.

*Adjusting for all other predictors of change that had p<0.05 in the unadjusted analysis

**p-value for test of heterogeneity of effect across subgroups

***Lagged variables (measured at prior wave).

Figure 1: Flow chart showing selection into cohorts



Supplementary Table 1: Characteristics of UKHLS Wave 8/9 participants by whether participated in the COVID-19 web-survey, unweighted analysis

	Responders (%)	Non-responders (%)*
N	17,452	24,999
Sex		
Men	7,287 (37.8)	11,994 (62.2)
Women	10,165 (43.9)	13,005 (56.1)
Age, years		
16-24	1,543 (31.4)	3,364 (68.6)
25-34	1,950 (35.4)	3,556 (64.6)
35-44	2,784 (41.0)	4,002 (59.0)
45-54	3,506 (45.6)	4,176 (54.4)
55-69	5,036 (50.8)	4,881 (49.2)
70 or more	2,633 (34.4)	5,020 (65.6)
Ethnicity		
White British	14,029 (44.9)	17,220 (55.1)
White non-British	779 (37.4)	1,302 (62.6)
Mixed	284 (35.5)	515 (64.5)
Asian	1,281 (24.9)	3,864 (75.1)
Black	392 (20.4)	1,532 (79.6)
Other	87 (26.1)	247 (74.0)
Equivalised household income quintile		
Lowest	2,163 (27.7)	5,638 (72.3)
2nd	2,611 (32.7)	5,376 (67.3)
3rd	3,146 (38.1)	5,108 (61.9)
4th	3,957 (46.3)	4,597 (53.7)
Highest	4,395 (52.2)	4,026 (47.8)
Age of youngest child in household		
None	12,221 (42.3)	16,682 (57.7)
0 to 5 years	1,756 (33.6)	3,469 (66.4)
6 to 15 years	3,475 (45.1)	4,228 (54.9)
GHQ score (mean, ±SD)	11.2 (±5.5)	11.3 (±5.7)

* All participants in Waves 8 or 9 who did not take part in the Covid-19 web-survey, including those deemed ineligible. Raw data, before corrective weighting applied.

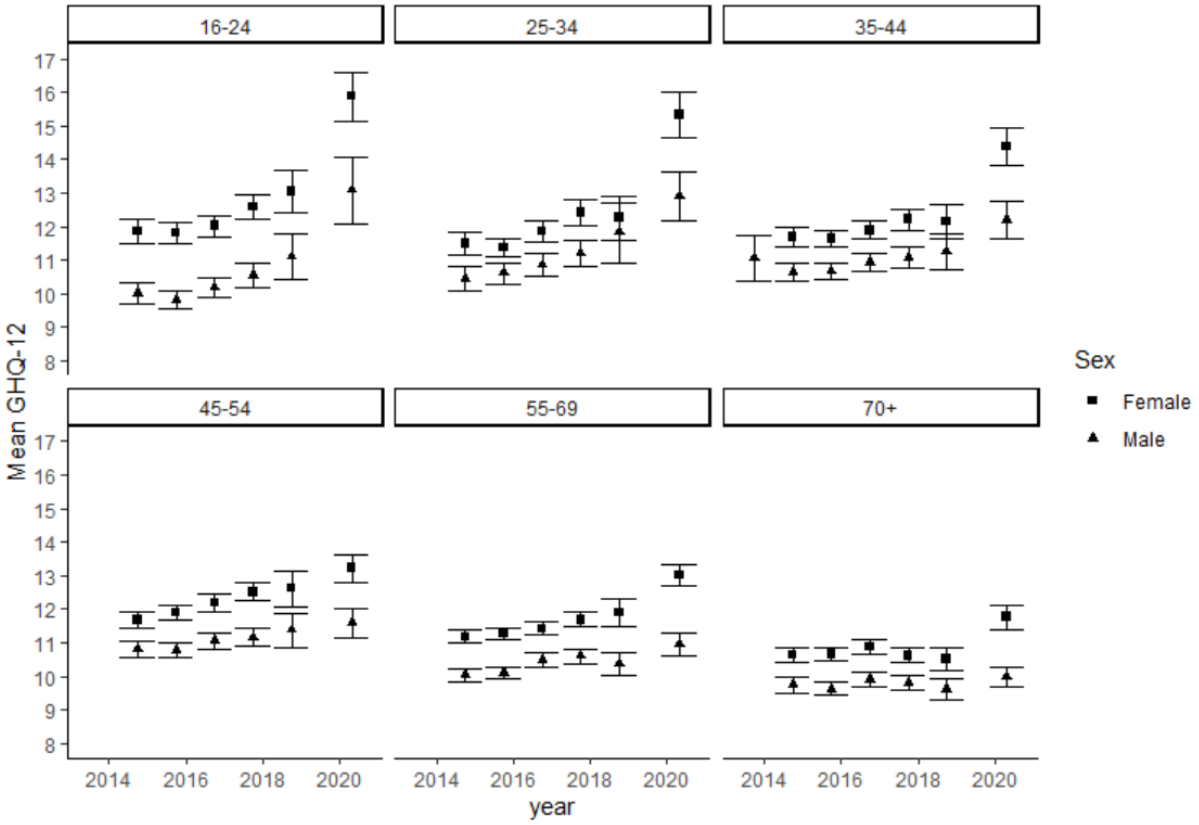
Supplementary Table 2: Mean GHQ-12 score and prevalence of clinically significant level of mental distress overall and by age and sex, by year

	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019	Apr-20
N	26,979	44,024	39,984	33,540	12,312	17,452
Mean GHQ-12 total						
Women, by age						
16-24	11·9 [11·5, 12·2]	11·8 [11·5, 12·1]	12·0 [11·7, 12·3]	12·6 [12·2, 13·0]	13·1 [12·4, 13·7]	15·9 [15·2, 16·6]
25-34	11·5 [11·2, 11·8]	11·4 [11·1, 11·6]	11·9 [11·5, 12·2]	12·4 [12·0, 12·8]	12·3 [11·6, 12·9]	15·3 [14·7, 16·0]
35-44	11·7 [11·4, 12·0]	11·7 [11·4, 11·9]	11·9 [11·6, 12·2]	12·2 [11·9, 12·5]	12·2 [11·6, 12·7]	14·4 [13·8, 14·9]
45-54	11·7 [11·4, 11·9]	11·9 [11·7, 12·1]	12·2 [11·9, 12·4]	12·5 [12·2, 12·8]	12·6 [12·1, 13·1]	13·2 [12·8, 13·6]
55-69	11·2 [11·0, 11·4]	11·3 [11·1, 11·5]	11·4 [11·2, 11·6]	11·7 [11·5, 11·9]	11·9 [11·5, 12·3]	13·0 [12·7, 13·3]
>=70	10·6 [10·4, 10·9]	10·7 [10·5, 10·9]	10·9 [10·7, 11·1]	10·6 [10·4, 10·8]	10·5 [10·2, 10·9]	11·8 [11·4, 12·1]
Men, by age						
16-24	10·0 [9·7, 10·3]	9·8 [9·6, 10·1]	10·2 [9·9, 10·5]	10·5 [10·2, 10·9]	11·1 [10·4, 11·8]	13·1 [12·1, 14·1]
25-34	10·5 [10·1, 10·8]	10·6 [10·3, 10·9]	10·9 [10·5, 11·2]	11·2 [10·8, 11·6]	11·8 [10·9, 12·7]	12·9 [12·2, 13·6]
35-44	10·6 [10·4, 10·9]	10·7 [10·4, 10·9]	10·9 [10·7, 11·2]	11·1 [10·8, 11·4]	11·3 [10·7, 11·8]	12·2 [11·6, 12·8]
45-54	10·8 [10·5, 11·1]	10·8 [10·6, 11·0]	11·1 [10·8, 11·3]	11·1 [10·9, 11·4]	11·4 [10·9, 11·9]	11·6 [11·2, 12·0]
55-69	10·0 [9·8, 10·2]	10·1 [9·9, 10·3]	10·5 [10·3, 10·7]	10·6 [10·4, 10·8]	10·4 [10·0, 10·7]	10·9 [10·6, 11·3]
>=70	9·8 [9·5, 10·0]	9·6 [9·4, 9·8]	9·9 [9·7, 10·1]	9·8 [9·6, 10·0]	9·6 [9·3, 9·9]	10·0 [9·7, 10·3]
Proportion with significant level of mental distress*						
Women, by age						
16-24	24·8 [22·1, 27·5]	25·5 [23·3, 27·6]	24·2 [22·0, 26·4]	29·8 [27·2, 32·3]	32·0 [27·5, 36·5]	44·0 [39·2, 48·9]
25-34	21·0 [18·7, 23·3]	20·2 [18·3, 22·1]	23·0 [20·8, 25·1]	24·5 [21·9, 27·1]	24·3 [19·9, 28·7]	40·4 [36·2, 44·6]
35-44	20·9 [18·9, 23·0]	20·8 [19·1, 22·4]	22·6 [20·7, 24·4]	23·5 [21·3, 25·6]	25·3 [21·5, 29·1]	37·9 [34·6, 41·3]
45-54	20·7 [19·0, 22·5]	21·3 [19·8, 22·9]	22·9 [21·3, 24·6]	24·6 [22·7, 26·5]	25·6 [22·2, 29·0]	31·3 [28·7, 34·0]
55-69	17·4 [16·1, 18·8]	18·2 [17·0, 19·5]	19·1 [17·7, 20·4]	20·6 [19·2, 22·1]	21·8 [19·2, 24·5]	30·9 [28·7, 33·0]
>=70	14·9 [13·2, 16·6]	14·8 [13·4, 16·2]	16·4 [14·9, 17·8]	14·8 [13·3, 16·4]	12·9 [10·6, 15·3]	21·8 [19·0, 24·7]

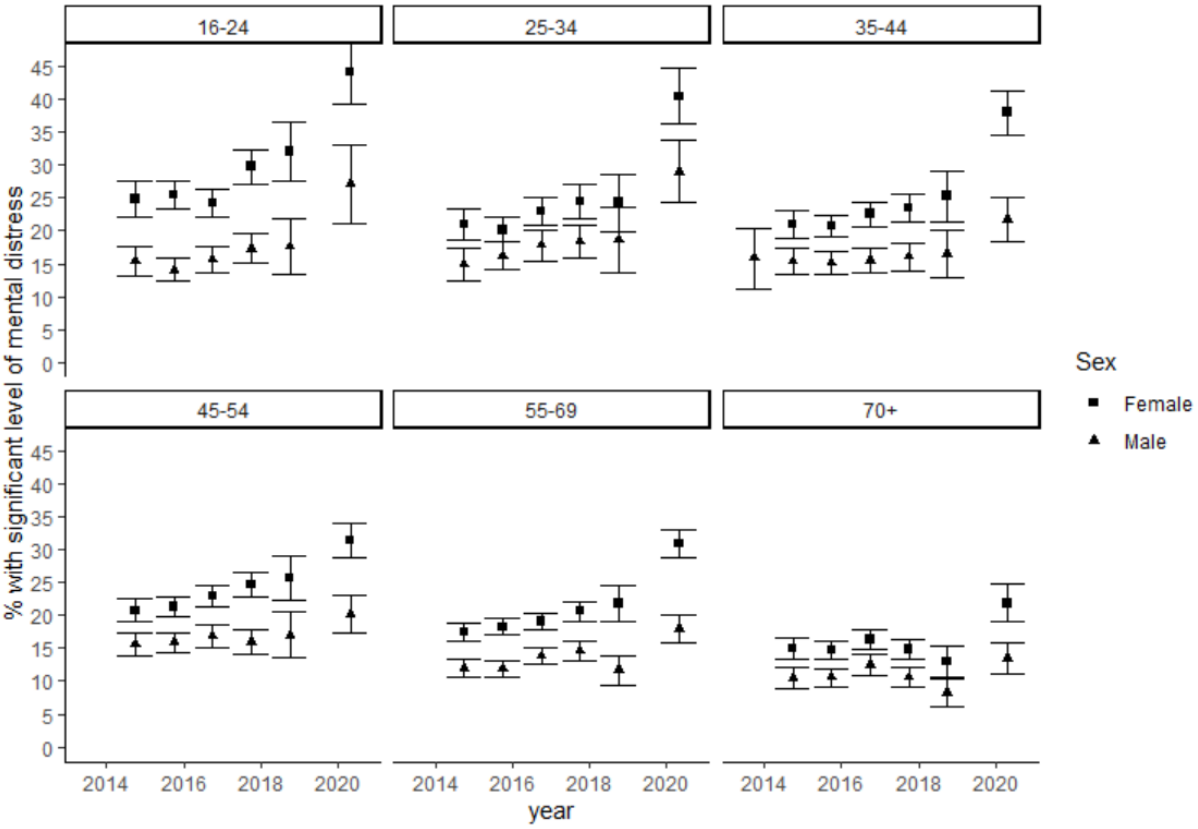
Men, by age						
16-24	15·3 [13·0, 17·6]	14·0 [12·3, 15·8]	15·6 [13·6, 17·6]	17·3 [15·0, 19·5]	17·6 [13·5, 21·8]	27·1 [21·2, 33·0]
25-34	14·9 [12·5, 17·4]	16·2 [14·1, 18·3]	17·8 [15·5, 20·2]	18·4 [15·8, 20·9]	18·5 [13·6, 23·5]	28·9 [24·3, 33·6]
35-44	15·3 [13·3, 17·3]	15·2 [13·4, 16·9]	15·5 [13·8, 17·3]	16·1 [14·0, 18·2]	16·5 [12·9, 20·1]	21·7 [18·4, 25·1]
45-54	15·6 [13·8, 17·3]	15·9 [14·4, 17·4]	16·8 [15·2, 18·5]	15·9 [14·2, 17·7]	17·0 [13·5, 20·4]	20·2 [17·4, 23·0]
55-69	11·9 [10·6, 13·2]	11·9 [10·7, 13·0]	13·9 [12·6, 15·1]	14·6 [13·1, 16·1]	11·7 [9·5, 13·9]	17·9 [15·7, 20·0]
>=70	10·5 [8·9, 12·1]	10·5 [9·2, 11·9]	12·5 [10·9, 14·0]	10·6 [9·2, 12·1]	8·3 [6·2, 10·3]	13·5 [11·1, 15·9]

Sample sizes are true (unweighted). All analyses are weighted, adjusting for complex survey design and non-response.

* GHQ-12 score 4 or more.



Supplementary Figure 1: Mean GHQ-12 score by age and sex, 2014-2020 weighted and adjusting for complex survey design and non-response.



Supplementary Figure 2: Percentage significant level of mental distress by age and sex, 2014-2020 weighted and adjusting for complex survey design and non-response