

Psychological distress from adolescence to early old age: Evidence from the 1946, 1958 and 1970 British birth cohorts

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Key Points

Question:

What is the profile of psychological distress from adolescence to early old age? Does it differ across generations and sex?

Findings:

Analysis of three British birth cohorts (n=29,655) found that psychological distress is at its highest level in midlife among both sexes, particularly in the most recently born generation

Meaning:

Midlife appears to be a high-risk life-course phase for psychological distress; it is important for prevention and management to understand the factors underlying this.

Abstract

Importance:

Mental health disorders cause enormous burden. Longitudinal studies can help identify high-risk life phases—with modifiable risk factors—and facilitate early detection and prevention of disorder.

Objective:

To study the profile of psychological distress across three British birth cohorts spanning adolescence to early old age.

Design:

We used data from three British birth cohorts: the 1946 MRC National Survey of Health and Development (1946 cohort; n=5,362), the 1958 National Child Development Study (1958 cohort; n=17,415), and the 1970 British Cohort Study (1970 cohort; n=17,196). The data analysis was conducted between 5th September 2017 and 28th June 2018.

Setting:

Population-based surveys.

Participants:

We excluded those who died or emigrated from Britain and had no single valid measure of psychological distress between age 15-69 in 1946 cohort (n=3,512), age 16-50 in 1958 (n=13,491) and age 16-46 in 1970 cohort (n=12,652).

Exposure:

The exposure was age, year of birth, sex.

Main Outcome(s) and Measure(s):

The outcome variable was a binary indicator of 'caseness', based on thresholds derived from measures of psychological distress such as the General Health Questionnaire-28 or the Malaise Inventory.

Results:

Within the observational period—peak in psychological distress was observed in midlife in all cohorts. In 1946 cohort, the frequency of distress decreased from age 15 to 36, increased from age 36 to 53 when it peaked (e.g. males: 14.3%, 95% CI, 12.4-16.2) and decreased again from age 53 to 69 in both sexes. In two other cohorts, the frequency also peaked in midlife,

at age 50 in 1958 (e.g. males: 11.2%, 95% CI, 10.3-12.1) and age 42 in 1970 (e.g. males: 17.7%, 95% CI, 16.6-18.9).

Conclusions and Relevance:

This is the first study investigating the profile of psychological distress in the same individuals over time in three population based prospective studies, including—to the best of our knowledge—the longest continuous follow up of this outcome (54 years) from age 15 to 69. Across three post-war British cohorts (observed until age 69: 1946 cohort, age 50: 1958 cohort, age 46: 1970 cohort) midlife appears to be a particularly vulnerable phase for experiencing psychological distress, with the highest psychological distress observed in the most-recently born cohort. Understanding the reasons for the midlife peak will be important for prevention and management of mental health problems.

Introduction

Mental health disorders are the leading cause of non-fatal disease burden¹ and their impact has increased over the last three decades.² Hence, it is vital to build a high-quality evidence-base to inform the development of interventions and policies. Longitudinal studies can help us achieve this by identifying high-risk life periods—with modifiable risk factors—and facilitate prevention and early detection of disorder.³ Of equal importance, cross-cohort comparisons of distress profiles can also elucidate whether risk periods are stable or vary according to changing social and economic circumstances.⁴ For example, those born in the early 70s were exposed to economic and labour market turbulence as well as social changes, such as rising rates of divorce⁴—factors that have been linked to higher psychological distress.⁵

Currently, the evidence in the UK, as well as other high-income countries, relies on repeated cross-sectional or longitudinal studies following individuals over a short time period, which tend to indicate worsening mental health until midlife, followed by an improvement at early old age.⁶⁻⁸ However, this apparent improvement could be due to confounding from cohort effects, as younger cohorts have been found to have worse mental health.^{8,9} While some studies have made statistical adjustments for cohort and age, findings are inconsistent;⁸⁻¹⁰ and there is need for research using comparable birth cohorts followed-up across life.⁸⁻¹⁰

To address this gap in the literature, we used three British birth cohorts—initiated in 1946 (the MRC National Survey of Health and Development; 1946 cohort), 1958 (National Child Development Study; 1958 cohort), and 1970 (the British Cohort Study; 1970 cohort), to study the profile of psychological distress from adolescence to early old age within the same individuals. A comparison across cohorts allows us to test cohort differences and enables greater generalisation of findings across post-WW2 generations. We hypothesised that the psychological distress would peak in midlife in all cohorts, and decline in early old age in the 1946; and that the magnitude of this midlife peak would increase across the cohorts.^{6, 7, 11, 12}

Methods

Sample

We used data from three British birth cohorts: 1946 (n=5,362),^{13, 14} 1958 (n=17,415),¹⁵ and 1970 (n=17,196).¹⁵ Details about the history, design and features of these studies can be found elsewhere.¹³⁻¹⁶ In longitudinal analyses, we excluded those who died or emigrated from Britain or those with no valid measure of psychological distress between age 15-16 and 69 (analytical samples: 1946 n=3,512; 1958 n=13,491; 1970 n=12,652).

Measures

The outcome variable was a binary indicator of ‘caseness’, based on thresholds derived from measures of psychological distress (Table 1; eAppendix 1; eTable 1). The 1946 cohort included adolescent internalising symptoms reported by teachers at age 15 – using a forerunner of the Rutter ‘A’ scale¹⁷; a clinical interview for the frequency and severity of psychiatric symptoms in the preceding month at age 36 (the Present State Examination)¹⁸;

an interviewer-administered 18-item instrument derived from the PSE, focusing on symptoms of anxiety and depression during the preceding year at age 43 (the Psychiatric Symptom Frequency)¹⁹; and a self-administered questionnaire assessing symptoms of anxiety and depression in the preceding 4 weeks at ages 53, 60-64 and 69 (the 28-item General Health Questionnaire)²⁰. The latter correlates highly with the Present State Examination.²¹ The 1958 and 1970 cohorts used the Rutter 'A' scale at age 16,²² which was completed by mothers of the cohort members during the home interview. At all other ages (1958: ages 16, 23, 33, 42, 50; 1970: 16, 26, 30, 34, 42, 46) cohort members completed the Malaise Inventory,²² a measure of psychological distress.

<Insert Table 1 here>

Analytical strategy

Prevalence of psychological distress was estimated using multiply imputed samples ($n=20$) excluding those who were deceased or permanent emigrants at each data cross-section (age 15-16: all cohorts; 23-26: 1958 and 1970; 33-36: all cohorts; 42-43: all cohorts; 50-53: 1946 and 1958) (eTable 2 & 3). The rates across cohorts were compared at each overlapping age using logistic regression (eTable 4).

The profile of psychological distress was modelled separately for each cohort using a logit piecewise growth model within a multilevel framework, where psychological distress measurements (level 1) were nested within individuals (level 2).²³ We split age into intervals to capture the non-linear profile of psychological distress at different life stages, while obtaining a continuous function over the whole observation period. We specified: two 'knots' for the 1946 cohort resulting in three age intervals (age 15 to 35, 36 to 53, 53 to 69); one 'knot' for the 1958 cohort resulting in two age intervals (age 16 to 33, 33 to 50) and one 'knot' for the 1970 cohort also resulting in two age intervals (age 16 to 30 and 30 to 46). Due to evidence of non-linearity, as indicated by the Wald test, squared age terms were additionally included for the 1970 and 1958 cohorts. Due to evidence of sex differences across cohorts ($\text{sex} \times \text{cohort} \times \text{age}$: $p < 0.001$), all models were stratified by sex.

The fixed part of the models included cohort, sex, age, and the intercept. The random part of the models comprised the intercept variance only as the variances around the slopes were very low (details available from the corresponding author). All models included weights to account for the stratified sample of the 1946 cohort, with participants from the 1958 and 1970 cohorts being given the weighting value of one. All analyses were conducted using STATA 15.²⁴

Missing data

The extent of missing data was greater in later born cohorts (eAppendix 2; eTable 5); for instance at age 42-43 the outcome data were missing in 22.4% of the eligible sample in 1946, 25.8% in 1958 and 37.7% in 1970. The strategies to preserve sample representativeness and reduce bias were maximum likelihood used in longitudinal models and multiple imputation with chained equations (20 imputations) for the cross-sectional prevalence rates (eAppendix 2; eTable 2 & 3), both under the missing at random assumption.²⁵

Sensitivity analysis

We report mean number of symptoms based on individual comparable items within (9 items for 1958 and 1970; 10 items for 1946) and across cohorts (5 items) in order to ensure that the obtained profile of psychological distress and cross-cohorts differences were not due to differences in items wording and definitions of binary 'caseness' indicators (eAppendix 3; eTable 6). To examine if results were similar when using continuous instead of binary operationalisation of psychological distress, we report cohort-stratified means and distributions of number of symptoms (eAppendix 4).

Results

Prevalence

The prevalence of psychological distress, based on multiply imputed data, was highest in midlife in all three cohorts (at age 53 in 1946, 50 in 1958 and 42 in 1970) in both sexes (Figure 1 & 2; eTable 2 & 3). However, prevalence was also high at age 26 in the 1970 cohort, particularly among females. Prevalence decreased in the 1946 cohort between midlife and older age. In males and females, the 1970 cohort had consistently higher prevalence across all ages than the two other cohorts except for age 15-16, with the greatest relative difference at age 33-34 (e.g. males odds of distress in the 1970 vs 1946: 3.79, 95% CI 2.71–5.30) (eTable 4). The prevalence was slightly higher in 1958 than in 1946 at age 33-36 and the opposite was found at age 50-53. The prevalence was consistently higher among females than males in all three cohorts and across all ages. Similar findings were found when restricting analyses to samples with valid outcome data at all ages (not shown).

<Insert Figure 1 & 2 here>

Profile of psychological distress

Based on longitudinal modelling, peak psychological distress was observed in midlife in all cohorts (Figure 3). There was a decline in distress in 1946 from age 53 until the last observation at age 69. The profile of distress varied somewhat across cohorts. In males and females, there was a slight decrease in probability of psychological distress between age 15-16 and 33-36 in the 1946 and 1958 cohorts (Figure 3; Table 2), whereas psychological distress increased from age 16 to 26, subsequently declining up to age 30 in the 1970 cohort. The probability of distress was consistently higher in the 1970 cohort than in the 1946 and 1958 cohorts across the adulthood, in both sexes.

<Insert Figure 3 here>

Sex differences

Females had consistently higher probability of psychological distress than males across all cohorts. There was little formal evidence of sex differences in the 1946 cohort (sex*age terms: $p>0.05$) and this fluctuated across adulthood in two other cohorts (sex*age terms: $p<0.05$), with the greatest difference at age 23-26 (9.2% in 1958 and 8.6% in 1970). At age 42-43, the latest overlapping measurement point across cohorts, sex differences were smaller in the 1970 cohort (1970: 3.4%; 1946: 6.8%; 1958: 6.9%; sex*cohort: $p<0.05$).

<Insert Table 2 here>

Sensitivity analysis

Mean number of symptoms based on comparable items

Consistent with findings using binary psychological distress, the mean number of symptoms was highest in mid-adulthood in all cohorts (age 53 in 1946; age 42 in 1958 and 1970) (eFigure 1 & 2) and highest in the 1970 cohort (eFigure 2). Interestingly, we did not observe a greater mean of symptoms at age 50 compared with age 42 in the 1958 cohort, despite a marginally greater prevalence of distress at age 50 in the main analysis. This was due to a simultaneous increase in proportion of those with no symptoms and with 4 or more symptoms ($p < 0.001$) at age 50. The 1946 and 1970 cohorts also experienced a rising proportion of those with 4 or more symptoms compared to earlier or later ages (eFigure 3 & 4).

Discussion

Main findings

Using longitudinal data across three birth cohorts, we found that psychological distress consistently peaked in midlife (within the observational period for each cohort)—at age 53 in the 1946 cohort, 50 in the 1958 cohort, and 42 in the 1970 cohort, mainly due to the increased number of those reporting many symptoms; and it was highest in 1970 across all studied ages except for age 15-16. Females had higher distress in all cohorts, with sex differences remaining stable in the 1946 cohort and fluctuating across life course stages in the two other cohorts. Sex differences were lower at age 42-43 in the 1970 cohort compared to the two other cohorts.

Comparison with other studies

The evidence produced through statistical adjustment of cohort effects has been somewhat inconsistent, with studies showing increasing, decreasing or flattening of symptoms during midlife.⁸⁻¹⁰ However, previous studies in the UK, which used cross-sectional data, or had limited follow-up, also indicated peak in distress in midlife.^{6,7} But, in the 1946 and 1958 cohorts the frequency of psychological distress started increasing from age 33-36, which is somewhat inconsistent with the previous evidence pointing towards an increase occurring already from adolescence (which we found in the 1970 cohort).²⁶ However, a flatter curve between age 16-19 and 33-39, similar to the one observed in our study, was also found in the British Household Panel Survey (2004).⁶

Our analysis expands previous studies that found higher psychological distress in those born in 1970 compared to the 1958 cohort from early-adulthood to midlife.^{11,12} We did not find evidence for lower psychological distress in the 1946 cohort compared to the 1958 cohort in the main analysis. This was somewhat inconsistent with previous, cross-sectional, evidence of an increase in symptoms of common mental disorders (40-60 year-old) in cohorts born in 1943-9 compared with those born in 1950-56.⁷ However, our comparison of mean number of symptoms, based on comparable items, did show higher psychological distress in the 1958 cohort.

A previous study found a reduction in sex differences between age 23 and 42 in the 1958 cohort, and between age 26 and 34 in the 1970 cohort.¹² However, this trend did not appear to occur when a longer age range was considered, as sex differences tended to fluctuate. Consistently with previous findings, we found reduced sex differences in those born in 1970 compared to the 1958 cohort,^{11, 12} whereas they were comparable across 1946 and 1958. Our findings contrast with those based on cross-sections of the British Household Panel Survey that showed continuously expanding sex differences across post-war generations due to a greater increase in distress among females.⁹

Strengths and limitations

The main strength of this study is that it investigates the profile of psychological distress in the same individuals over time in three population-based prospective studies, including—to the best of our knowledge—the longest continuous follow up of this outcome from age 15 to 69. Another strength is that the same measure of distress was used in two of the cohorts, which we found to be invariant across cohorts and sexes.¹¹ The key limitation of the study is due to different measures used in 1946 across ages and in comparison with 1958 and 1970. It is likely that those measures capture different dimensions of mental health and may under- or overestimate the true differences within and between cohorts (eAppendix 1; eTable 1). For instance, the GHQ-12 questionnaire—which is highly correlated with the GHQ-28 used in the 1946 cohort²⁷ and was available at age 30 in the 1970 and age 42 in the 1958 cohorts—returned a higher prevalence of psychological distress than the Malaise Inventory²⁸ (e.g. males: age 30 in 1970: 15.2% vs 10.7%; age 42 in 1958: 15.9% vs 9.6%). Hence, this could lead to overestimation of psychological distress at age 50-53 in the 1946 cohort compared to the 1958 cohort. However, when we compared five similar items from both measures, the average number of symptoms was higher, at all overlapping ages, in the 1958 compared to the 1946 cohort (eFigure 2). Nonetheless, when psychological distress was treated as a continuous measure—based on five comparable across cohorts items or ten within the 1946 cohort comparable items—the profile of distress in the 1946 cohort was consistent with the one observed by the frequency of ‘cases’—pointing towards the midlife peak in psychological distress. Psychological distress measures have poor sensitivity at the low spectrum of symptomology, as shown by the high proportion of those with no symptoms. As seen in our sensitivity analysis, this may lead to continuous measures of distress concealing a shift in distribution among those who are particularly vulnerable, hence justifying the use of ‘caseness’. Finally, our analysis relied on the missing at random assumption that is not empirically verifiable.²⁹ Not meeting this assumption may potentially lead to bias, also considering that we assumed an identical missing data-generating mechanism in all cohorts. However, we obtained consistent results based on complete case analysis (not shown), multiply imputed data with auxiliary variables and models using full information maximum likelihood.

Interpretation

The mechanism that underlies the observed midlife peak in psychological distress is not known. We speculate that perhaps experiences associated with particular stages in life,

referred to as age effects, may partially explain the rise of psychological distress in midlife. As elevated distress in midlife was found in all cohorts, it is unlikely due to period effects. Midlife tends to involve a “peak” in career, with midlife adults acquiring increasing responsibility as the “decision makers” in society, reducing leisure time.³⁰ This is, for instance, reflected by elevated job-related stress in midlife.³¹ Hence, declining quality of leisure time as well as time with friends and family may translate into higher psychological distress in midlife.³³ but more research is needed to empirically test these hypotheses.

The reasons for the decline in psychological distress after midlife are also unknown. Selective mortality is one of the candidate explanations, as those in poorer mental health are at a greater risk to die prematurely,³⁴ and absolute mortality rates have declined across the period investigated. However, considering that the mortality rates in the three cohorts are representative of those observed in their target populations, any effects of selective mortality due to mental health reflect a population selection process and not sample specific bias. This implies that inferences based on participants alive throughout the entire observation period (e.g. until age 69 in the 1946 cohort) are representative of their values in the population. Older individual may also experience declining distress due to a relief from major midlife stressors, for instance, retirement or stabilisation in family life. Indeed, the perceived daily stress reduces in this life phase; however this reduction does not appear to be associated with employment or marital status.³⁵ Others suggested that older people shift from attainment-related goals, such as status or skills, towards those that help them maintain emotional stability—a phenomenon known as socioemotional selectivity.³⁶ For instance, older individuals may be more likely to invest in relationships and activities that are positive and rewarding whilst ceasing those that are not. This, in turn, helps them to confront stressors and adversity.³⁶ It is also possible that mental health problems more specific to old age are not well-captured by conventional symptom scales, hence underestimating frequency of distress. For instance, physical symptoms of distress, such as decreased energy, fatigue or difficulty with sleeping, may be normalised and explained through deteriorating health related to ageing rather than emotional state. Nonetheless, the evidence on differential association between risk factors and psychological distress across different ages is currently lacking.

Higher psychological distress in the 1970 compared with the 1946 and 1958 cohorts was observed across adulthood—suggesting a cohort effect, rather a period effect, is a more probable explanation for the findings. The generation born in 1970 experienced economic and labour market transformation and increasing socioeconomic inequality, compared with those born in 1946 and 1958.⁴ The 1970-born generation was particularly disadvantaged in their transition from education to work, as they entered the labour market in mid-1980s during high unemployment among young people.⁴ As economic circumstances are strongly associated with mental health,³⁷ this may be one reason for worse mental distress in the 1970 cohort which emerged earlier in adulthood. There were also changes in family life associated with poorer mental health, such as a rise in divorce and single parenthood in each successive cohort.^{4, 11} Economic downturns, which have been found to affect men’s mental health to a greater extent,³⁷ as well as dispersion of traditional manufacturing mainly

employing men,⁴ may explain a greater increase in distress among men - leading to reduced sex differences in the 1970 cohort. Potential changes over time in the interpretation of items, as well as cohort differences in awareness and reporting of mental health symptoms may also underlie the observed differences. However, we have recently shown that the passage of time has not differentially affected the interpretation of mental health survey questions in the 1958 and 1970 cohorts.¹¹

Conclusion

The current study used data from the longest running British birth cohort, which allowed for the first time the observation of the profile of psychological distress from adolescence (age 15) to early old age (age 69) within the same individuals. In addition, to increase generalisation of our findings in the profile of psychological distress we included two other birth cohorts (born in 1958 and 1970). Across three post-war British cohorts, midlife appears to be a particularly vulnerable phase for experiencing psychological distress, with the highest levels observed among the most-recently born cohort. Further research aiming to understand the reasons for this midlife peak will be important for prevention and management.

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Table 1. Measures of psychological distress used across the cohorts.

	Age 15-16	Age 23-26	Age 30	Age 33-36	Age 42-43	Age 46	Age 50-53	Age 60-64	Age 69
1946	Forerunner of the Rutter 'A'			Present State Examination	Psychiatric Symptoms Frequency		GHQ-28	GHQ-28	GHQ-28
1958	Rutter 'A'	Malaise Inventory		Malaise Inventory	Malaise Inventory		Malaise Inventory		
1970	Rutter 'A'	Malaise Inventory	Malaise Inventory	Malaise Inventory	Malaise Inventory	Malaise Inventory			

Note. GHQ-28 = General Health Questionnaire.

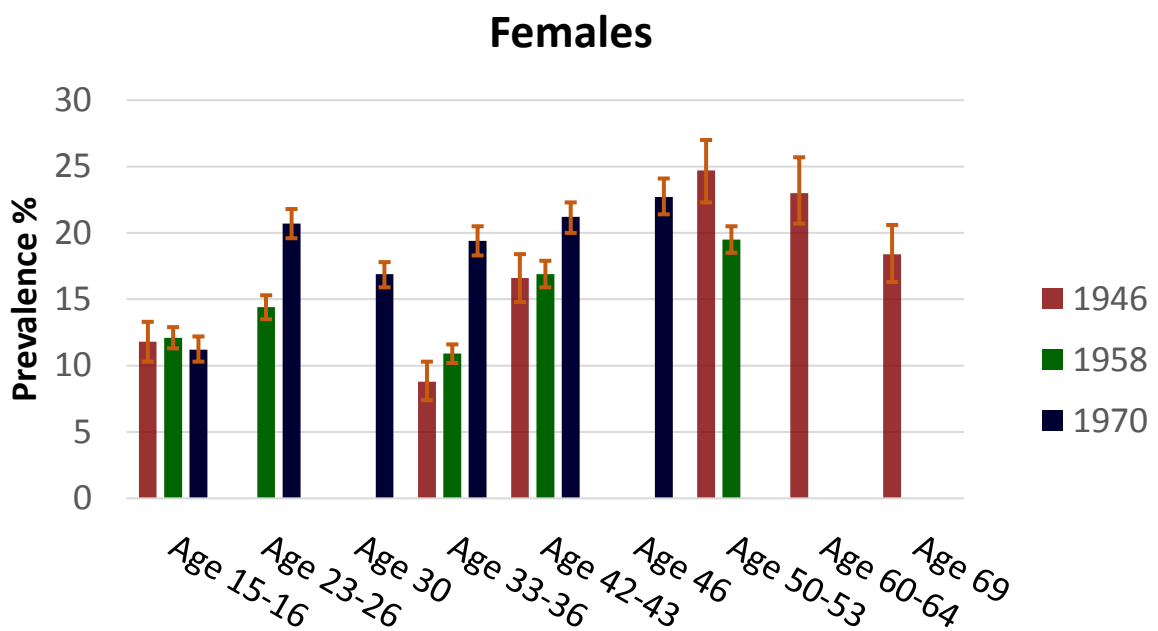
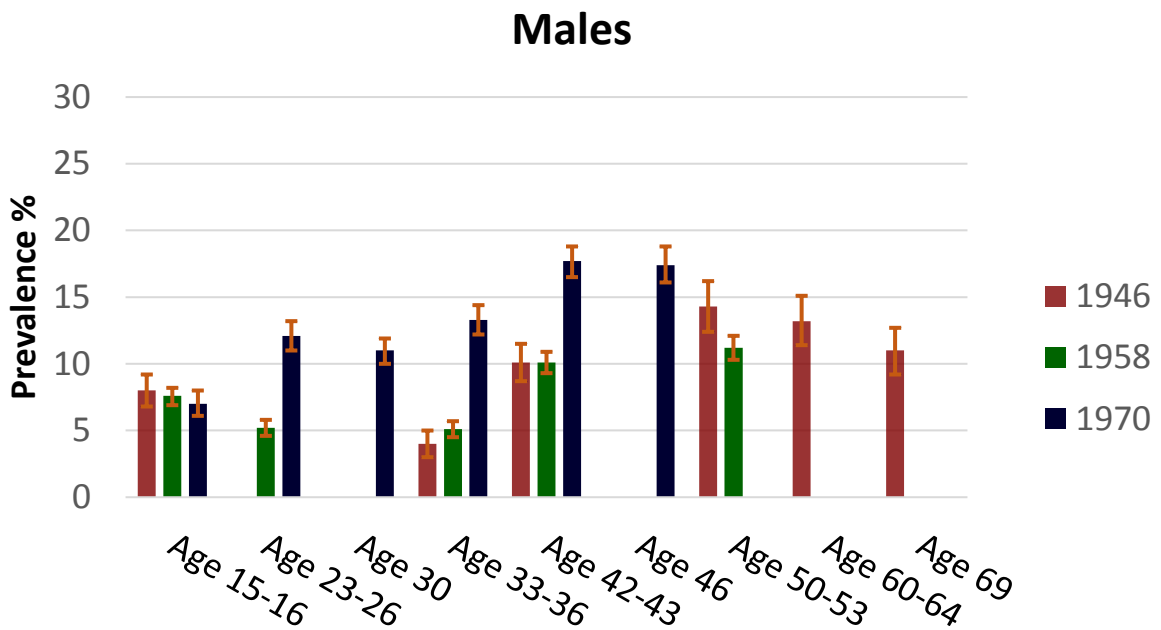


Figure 1 & 2. Sex- and cohort-stratified age-specific prevalence of psychological distress based on multiply imputed data. The estimates include those who were alive and residents of Great Britain at each data cross-section.

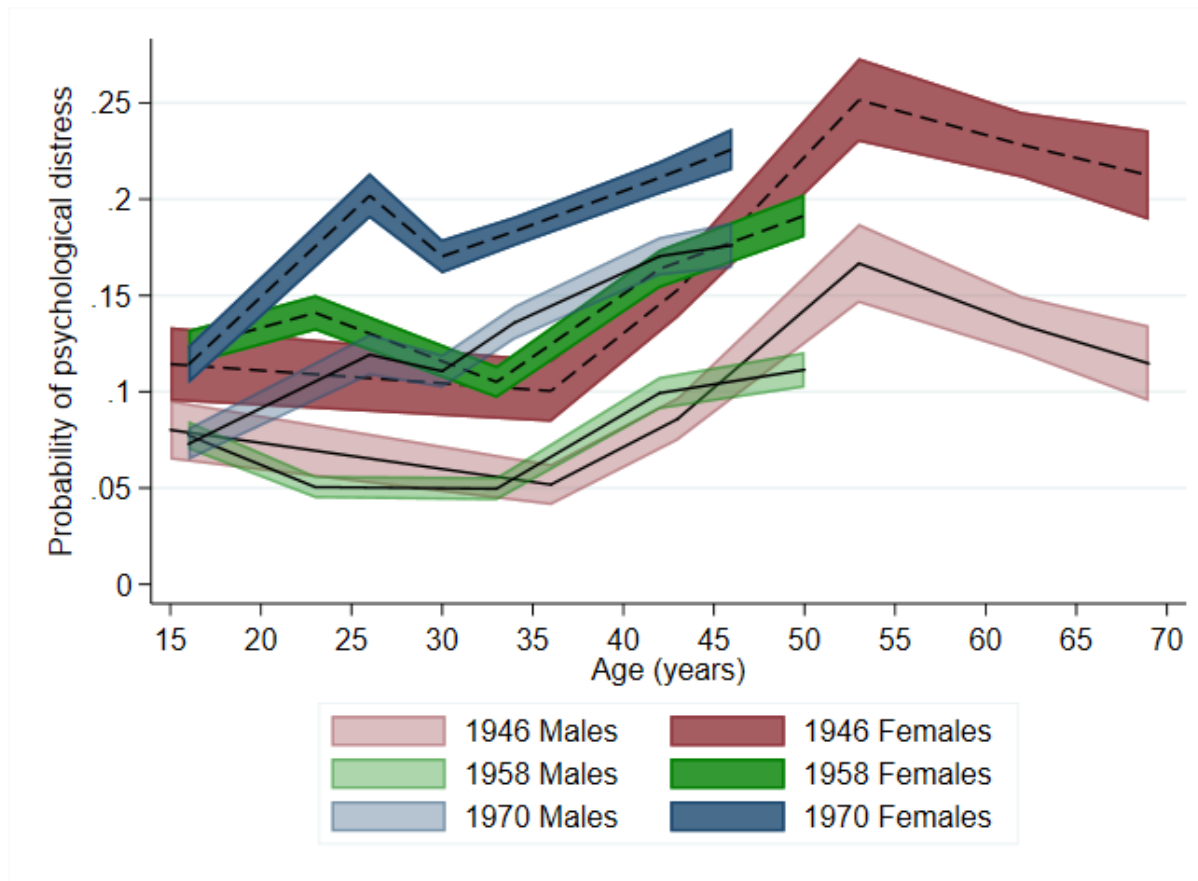


Figure 3. Psychological distress across adulthood in 1946, 1958, and 1970; estimates based on the piecewise logit multilevel growth model.

Table 2. The psychological distress profile in the 1946, 1958, and 1970 cohorts.

	1946		1958		1970	
	Males (n=1,693)	Females (n=1,707)	Males (n=6,813)	Females (n=6,678)	Males (n=6,292)	Females (n=6,360)
	1946		1958		1970	
	Males (n=1,693)	Females (n=1,707)	Males (n=6,813)	Females (n=6,678)	Males (n=6,292)	Females (n=6,360)
	Coefficient (CI 95%)		Coefficient (CI 95%)		Coefficient (CI 95%)	
<i>1946</i>						
Intercept	-4.56 (-5.01, -4.11)	-3.53 (-3.89, -3.17)				
Intercept variance	7.54 (6.10, 9.33)	5.50 (4.60, 6.58)				
Slope 1 (Age 15-36)	-0.04 (-0.06, -0.01)	-0.01 (-0.03, 0.01)				
Slope 2 (Age 36-52)	0.12 (0.10, 0.15)	0.11 (0.08, 0.13)				
Slope 3 (Age 52-69)	-0.04 (-0.07, -0.02)	-0.02 (-0.04, -0.01)				
<i>1958</i>						
Intercept			-3.68 (-3.87, -3.50)	-2.86 (-3.00, -2.73)		
Intercept variance			3.58 (3.09, 4.14)	3.04 (2.72, 3.40)		
Slope 1 (Age 16-33)			-0.12 (-0.16, -0.08)	0.06 (0.03, 0.09)		
Slope 1 (Age 16-33) ²			0.01 (0.00, 0.01)	-0.00 (-0.01, -0.00)		
Slope 2 (Age 33-50)			0.16 (0.12, 0.19)	0.10 (0.07, 0.13)		
Slope 2 (Age 33-50) ²			-0.01 (-0.01, -0.00)	-0.00 (-0.00, -0.00)		
<i>1970</i>						
Intercept					-4.20 (-4.42, -3.98)	-3.12 (-3.27, -2.97)
Intercept variance					5.23 (4.61, 5.94)	3.637 (3.29, 4.02)
Slope 1 (Age 16-30)					0.16 (0.10, 0.22)	0.22 (0.18, 0.26)
Slope 1 (Age 16-30) ²					-0.01 (-0.01, -0.00)	-0.01 (-0.02, -0.01)
Slope 2 (Age 30-46)					0.10 (0.06, 0.14)	0.03 (0.03, 0.04)
Slope 2 (Age 30-46) ²					-0.00 (-0.01, -0.00)	
<i>Sex differences</i>						
Intercept	-4.90 (-5.34, -4.47)		-2.55 (-2.99, -2.11)		-4.72 (-5.29, -4.14)	
Intercept variance	5.91 (5.15, 6.77)		3.16 (2.89, 3.45)		4.11 (3.80, 4.45)	
Age	0.02 (0.02, 0.03)		-0.10 (-0.13, -0.08)		0.06 (0.02, 0.09)	
Age ²			0.20 (-0.34, 0.74)		-0.00 (-0.00, 0.00)	
Sex	0.66 (0.14, 1.18)		0.06 (0.02, 0.09)		0.63 (-0.08, 1.34)	
Age*sex	0.01 (-0.00, 0.02)		0.00 (0.00, 0.00)		0.02 (-0.02, 0.07)	
Age ² *sex	5.91 (5.15, 6.77)		-0.00 (-0.00, -0.00)		-0.00 (-0.00, 0.00)	

* Slope (Age 15-35)*cohort: p<0.001 for both sexes; slope (Age 35-52)*cohort: p<0.001 for both sexes.

Appendix

eAppendix 1. Detailed description of the measures used.

eTable 1. Measures of psychological distress used across the cohorts; details.

eTable 2a & 2b. Prevalence of psychological distress among males based on multiply imputed sample.

eTable 3. Prevalence of psychological distress among females based on multiply imputed sample.

eTable 4. The association between cohort and psychological distress; estimates from age- and sex- specific logistic regressions based on multiply imputed sample (sample sizes as above).

eAppendix 2. Detailed information about missing data.

eTable 5. Frequency and predictors of missing data in distress at overlapping ages.

eAppendix 3. The life course profile of psychological distress based on the count of symptoms across four comparable items.

eTable 6. Comparable items across measures of psychological distress.

eFigure 1. Mean number of symptoms based on items comparable within cohorts: 1946 (ten items), 1958 (nine items), 1970 (nine items).

eFigure 2. Mean number of symptoms based on five comparable items within and across cohorts.

eFigure 3. Distribution of symptoms based on items comparable within cohorts: 1946 (ten items), 1958 (nine items), 1970 (nine items).

eFigure 4. Distribution of symptoms based on five items comparable within and across cohorts.

eReferences.

eAppendix 1. Detailed description of the measures used.

There was a range of measures of psychological distress used within the 1946 (eTable 1). At age 15 adolescent internalising symptoms were reported by teachers using a forerunner of the Rutter 'A' scale (e.g. "timid child", "very anxious").¹ At age 36, the Present State Examination was used, which is a clinical interview for the frequency and severity of psychiatric symptoms in the preceding month.² The Psychiatric Symptom Frequency scale was used at age 43, based on items from the Present State Examination, which is an interviewer-administered 18-item instrument focusing on symptoms of anxiety and depression during the preceding year.³ At ages 53, 60-64 and 69, the 28-item General Health Questionnaire was employed, which is a self-administered questionnaire assessing symptoms of anxiety and depression in the preceding 4 weeks⁴; it correlates highly with the Present State Examination total symptom score.⁵ In 1958 and 1970, at age 16 a modified version of the Rutter 'A' scale was utilised,⁶ which was completed by mothers of the cohort members during the home interview. At all other ages cohort members completed the Malaise Inventory,⁶ a measure of psychological distress level, or depression and anxiety symptoms. The longer version of the Malaise Inventory, including 24 'yes-no' questions was used at age 23, 33, 42 in 1958 and at age 26, 30 in 1970. At age 34 within 1970, 9 of the 24 questions were asked (in the 'yes-no' format). To aid comparability only the shorter version was used in the current study across all ages. The shorter version was found to correlate highly with the 24-item version ($r_{1958} = 0.91$ at age 42 years and $r_{1970} = 0.92$ at age 30 years⁷). All measures were found to be psychometrically robust (eTable 1). The thresholds, based on validity studies, identified the potential for a diagnosis of Common Mental Disorder (depression and anxiety) (eTable 1). Nonetheless, the definition of 'cases' varied across the different measures. For instance, the Psychiatric Symptoms Frequency used generic criteria of one having been in contact with a doctor due to "nervous or emotional trouble or depression",³ whereas the study on the Malaise Inventory adopted a definition including any mental health longstanding illnesses, as coded with the ICD-9 classification.⁸ Corresponding thresholds for the measures of psychological distress at age 15/16 were not available. Hence following a previously used approach,⁹ we derived the thresholds based on the distribution of the latent means of the measure, with 91st to the 100th percentile indicating severe symptoms and being identified as cases.

eTable 1. Measures of psychological distress used across the cohorts; details.

Measure	Details	'Caseness' threshold	Psychometric (reliability/validity)/clinical properties
Forerunner of the Rutter 'A'	11 items assessing anxiety/depression and internalizing emotions and behaviors (e.g. "timid child"); 3-point scale—more, same, or less than classmates; reported by teachers.	91st to the 100th percentile of the latent score ⁹	Tested in general population: Cronbach's alpha = 0.71 ⁹ ; all items identified a common factor ^{10,11} ; cut-off point derived arbitrarily - sensitivity/specificity not studied. ⁹
Present State Examination	A clinical examination, conducted by a nurse, assessing the frequency and severity of a range of psychiatric symptoms in the preceding month.	5 or higher ¹²	Tested in general population: high agreement with clinical diagnosis of common mental health disorders (≈90%); high concurrent validity with other measures of psychological distress. ² A diagnostic tool, hence information on specificity and sensitivity not provided.
Psychiatric Symptoms Frequency	18 items (based on the Present State Examination); 5-point scale (0 = never in the last year; 1 = up to 10 days in total, less than once a Month; 5 = every day in the last year); assessing on symptoms of anxiety and depression during the preceding year; administered by a nurse.	23 or higher ³	Tested in general health care/general population (age ≈ 43); Cronbach's alpha = 0.88; all items identified a common factor; AUC against reports of contact with a doctor/use of prescribed medication for "nervous or emotional trouble or depression" (0.84 – 0.86). ³
GHQ-28	28 items assessing symptoms of anxiety and depression in the preceding 4 weeks; a 1 to 4 point Likert scale and recoded into binary values; self-administered.	5 or higher ¹³	Tested in general health care (adults): Cronbach's alpha = 0.82 – 0.86; ¹³ all items identified 4 factors explaining 62% variance in psychological distress; ⁴ AUC against diagnosed psychiatric morbidity (0.93). ¹³
Rutter 'A' scale	4 items assessing internalising symptoms (e.g. "often worried"); 3-point response scale ("does not apply", "applies somewhat", "certainly applies" to their child); reported by mother	91st to the 100th percentile of the latent score	Tested in general population; acceptable inter-rater reliability (r = 0.64) and retest reliability (r = 0.74) ⁶ ; cut-off point derived arbitrarily - sensitivity/specificity not studied.
Malaise Inventory	A shorter 9-item version (as opposed the full 24 items version); binary ('yes-no') response scale; self-administered.	4 or higher	Tested in general population (age 23-33); Cronbach's alpha = 0.70 – 0.80; all items identify a common factor; AUC against self-reported diagnosed psychiatric morbidity = 0.77 – 0.79). ¹⁴

* Sensitivity (the proportion of cases who are correctly identified) and specificity (the proportion of non-cases correctly identified) expressed as area under the curve

eTable 2. Prevalence of psychological distress among males based on multiply imputed sample.

Prevalence	1946		1958		1970	
	n	% (CI95%)	n	% (CI95%)	n	% (CI95%)
Age 15-16	2,355	9.0 (6.8, 9.2)	8,416	7.6 (6.9, 8.2)	9,082	7.0 (6.1, 7.9)
Age 23-26			8,250	5.2 (4.6, 5.8)	9,038	12.1 (11.3, 13.2)
Age 30					9,005	11.0 (10.3, 11.8)
Age 33-36	2,119	4.0 (3.0, 5.0)	8,121	5.1 (4.5, 5.7)	8,919	13.3 (12.1, 14.4)
Age 42-43	2,087	10.1 (8.7, 11.5)	8,108	10.1 (9.3, 10.9)	8,873	17.7 (16.6, 18.9)
Age 46					8,095	17.4 (16.1, 18.7)
Age 50-53	2,022	14.3 (12.4, 16.2)	7,969	11.2 (10.3, 12.1)		
Age 60-64	1,883	13.2 (11.4, 15.1)				
Age 69	1,835	11.0 (9.2, 12.7)				

eTable 3. Prevalence of psychological distress among females based on multiply imputed sample.

Prevalence	1946		1958		1970	
	n	% (CI95%)	n	% (CI95%)	n	% (CI95%)
Age 15-16	2,181	11.8 (10.3, 13.3)	8,017	12.1 (11.3, 12.9)	8,577	11.2 (10.3, 12.2)
Age 23-26			7,931	14.4 (13.6, 15.3)	8,565	20.7 (19.6, 21.8)
Age 30					8,517	16.9 (15.9, 17.8)
Age 33-36	2,044	8.8 (7.4, 10.3)	7,801	10.9 (10.1, 11.6)	8,455	19.4 (18.3, 20.5)
Age 42-43	2,019	16.6 (14.8, 18.4)	7,785	16.9 (16.0, 17.9)	8,431	21.2 (20.0, 22.3)
Age 46					7,757	22.7 (21.4, 24.1)
Age 50-53	1,976	24.7 (22.3, 27.0)	7,696	19.5 (18.4, 20.5)		
Age 60-64	1,867	23.0 (11.3, 17.0)				
Age 69	1,839	18.4 (16.3, 20.6)				

eTable 4. The association between cohort and psychological distress; estimates from age- and sex- specific logistic regressions based on multiply imputed sample (sample sizes as above).

	Age 15-16	Age 23-26	Age 33-36	Age 42-43	Age 50-53
	OR (CI95%)	OR (CI95%)	OR (CI95%)	OR (CI95%)	OR (CI95%)
Males					
1946	Reference		Reference	Reference	Reference
1958	0.96 (0.77, 1.19)	Reference	1.33 (0.93, 1.90)	0.99 (0.81, 1.23)	0.71 (0.58, 0.88)
1970	0.88 (0.70, 1.10)	2.51 (2.18, 2.90)	3.79 (2.71, 5.30)	2.01 (1.60, 2.54)	
Females					
1946	Reference		Reference	Reference	Reference
1958	1.00 (0.83, 1.20)	Reference	1.26 (1.00, 1.58)	1.00 (0.84, 1.20)	0.78 (0.66, 0.91)
1970	0.92 (0.76, 1.11)	1.55 (1.41, 1.70)	2.49 (1.99, 3.11)	1.32 (1.11, 1.57)	

eAppendix 2. Detailed information about missing data.

Several studies also examined the key determinants of missing data.¹⁶⁻¹⁹ The extent of missing data was greater in later born cohorts (eTable 2); for instance at age 42-43 the outcome data were missing in 22.4% of the eligible sample in 1946, 25.8% in 1958 and 37.7% in 1970. Being a male, of lower parental social class, experiencing psychological distress at preceding data sweep and having low birthweight were all predictive of missing data in psychological distress across all cohorts. At ages 15-16 and 42-43 there was evidence for systematic differences in the association between sex and missing psychological distress outcome ($p < 0.001$ for sex*cohort interaction), with more males having missing data in 1958 and 1970 than 1946. In addition, those of lower parental social class were more likely to have missing data at age 16 in 1970 compared to other cohorts. Finally, the association between experiencing psychological distress at a preceding age and having a missing outcome was a stronger in 1946 at ages 33-36 and 50-53 than in other cohorts ($p < 0.001$ and 0.002 respectively for distress*cohort), whereas it was stronger in 1970 at age 42 compared with 1946 and 1970 ($p = 0.02$).

In order to preserve sample representativeness and reduce bias, we used maximum likelihood (ML) and multiple imputation (MI), both under the assumption of the data missing at random, meaning that the estimates are valid if variables included in our models can explain the missingness mechanism.²⁰⁻²² The multiple imputation, generating 20 datasets, was conducted using chained equations. The cohort and sex-stratified imputation models included measures of psychological distress, sampling weights and auxiliary variables (birthweight and parental socioeconomic status). The results of analyses run on each dataset were pooled according to Rubin's rules.²³ Results using listwise deletion (details upon request) were highly comparable to those based on multiple imputation.

eTable 5. Frequency and predictors of missing data in distress at overlapping ages.

N (eligible sample)*	<u>Missing data in distress at</u>			
	Age 15-16	Age 33-34	Age 42	Age 50-53
	n (%)	n (%)	n (%)	n (%)
1946 (N=3,512)	705 (20.07)	794 (22.61)	785 (22.35)	939 (26.74)
1958 (N=13,491)	3,814 (28.27)	3,524 (26.12)	3,484 (25.82)	4,362 (32.33)
1970 (N=12,652)	5,277 (41.71)	3,883 (30.69)	4,763 (37.65)	
<u>Logistic regression estimates</u>	RR (CI95%)	RR (CI95%)	RR (CI95%)	RR (CI95%)
Birth cohort (1946 – reference category)				
1958	1.71 (1.61, 1.81)	1.13 (1.07, 1.19)	1.01 (0.96, 1.06)	1.17 (1.12, 1.22)
1970	2.66 (2.51, 2.81)	1.40 (1.33, 1.47)	1.56 (1.49, 1.64)	
Sex (male – reference category)	0.97 (0.94, 1.00)	0.82 (0.79, 0.85)	0.84 (0.81, 0.87)	0.96 (0.94, 0.98)
Sex*cohort (p value)	<0.001	0.41	<0.001	0.21
Father's occupational class (Class I – reference)				
II	0.97 (0.88, 1.07)	1.14 (1.00, 1.30)	1.11 (0.98, 1.25)	1.07 (1.01, 1.13)
III NM	0.89 (0.80, 0.99)	1.19 (1.04, 1.37)	1.13 (0.99, 1.28)	1.00 (0.94, 1.06)

III M	0.90 (0.82, 0.99)	1.44 (1.28, 1.63)	1.37 (1.23, 1.53)	1.02 (0.97, 1.08)
IV	0.89 (0.80, 0.98)	1.51 (1.33, 1.72)	1.42 (1.27, 1.60)	0.99 (0.93, 1.05)
V	0.88 (0.79, 0.99)	1.66 (1.45, 1.90)	1.55 (1.37, 1.75)	1.00 (0.94, 1.06)
Father's occupational class*cohort	<0.001	0.56	0.19	0.28
Distress at preceding age		1.27 (1.19, 1.36)	1.58 (1.47, 1.71)	1.28 (1.24, 1.33)
Distress at preceding age*cohort		<0.001	0.02	0.00
Normal birthweight (low: <2500g – reference)	0.95 (0.88, 1.02)	0.84 (0.78, 0.91)	0.87 (0.81, 0.93)	0.92 (0.88, 0.95)
Birthweight*cohort	0.48	0.93	0.20	0.22

*Eligible sample includes those who were born in Great Britain, have not died or permanently emigrated from Britain until the last data sweep included in the analyses and had at least one valid measure of psychological distress (i.e. with all items within the measure completed).

Note. RR = risk ratio; CI95% = 95% confidence interval

eAppendix 3. The cross-sectional prevalence of symptoms harmonised across and within cohorts

Methods

Individual items of psychological distress measures, comparable across and within cohorts, were identified as part of a larger project aiming to harmonise psychological distress measures across the British birth cohorts (led by the Cohort & Longitudinal Studies Enhancement Resources; <https://www.closer.ac.uk/>). For studying the profile of psychological distress within cohorts – ten comparable items, corresponding to the same symptom, were selected from measures within 1946 and nine items from the Malaise Inventory for 1958 and 1970. In addition, five comparable items were identified to facilitate comparison of 1958 and 1970 with 1946. The mean number of symptoms based on five selected items correlated highly with estimates based on the full scales (Pearson's $r > 0.8$). The comparability of the items was subsequently discussed with other research team members for validation purposes (comparable items for age 15-16 in 1946 and 1958 were not identified) (eTable 6). The response scales were binary variables indicating presence of a symptom. This sensitivity analysis was to ensure that differences in probability of distress were not due to thresholds of binary case indicators having been derived in different populations and according to varying definitions of 'caseness'. A cohort-stratified mean number of symptoms is presented for each age, based on complete cases at each data sweep (eFigure 1 within cohorts; eFigure 2 across cohorts). In addition, we present distribution of the symptoms across age and cohorts (eFigure 3 for 9/10 items; eFigure 4 for 5 items). For simplicity, the results are combined for males and females.

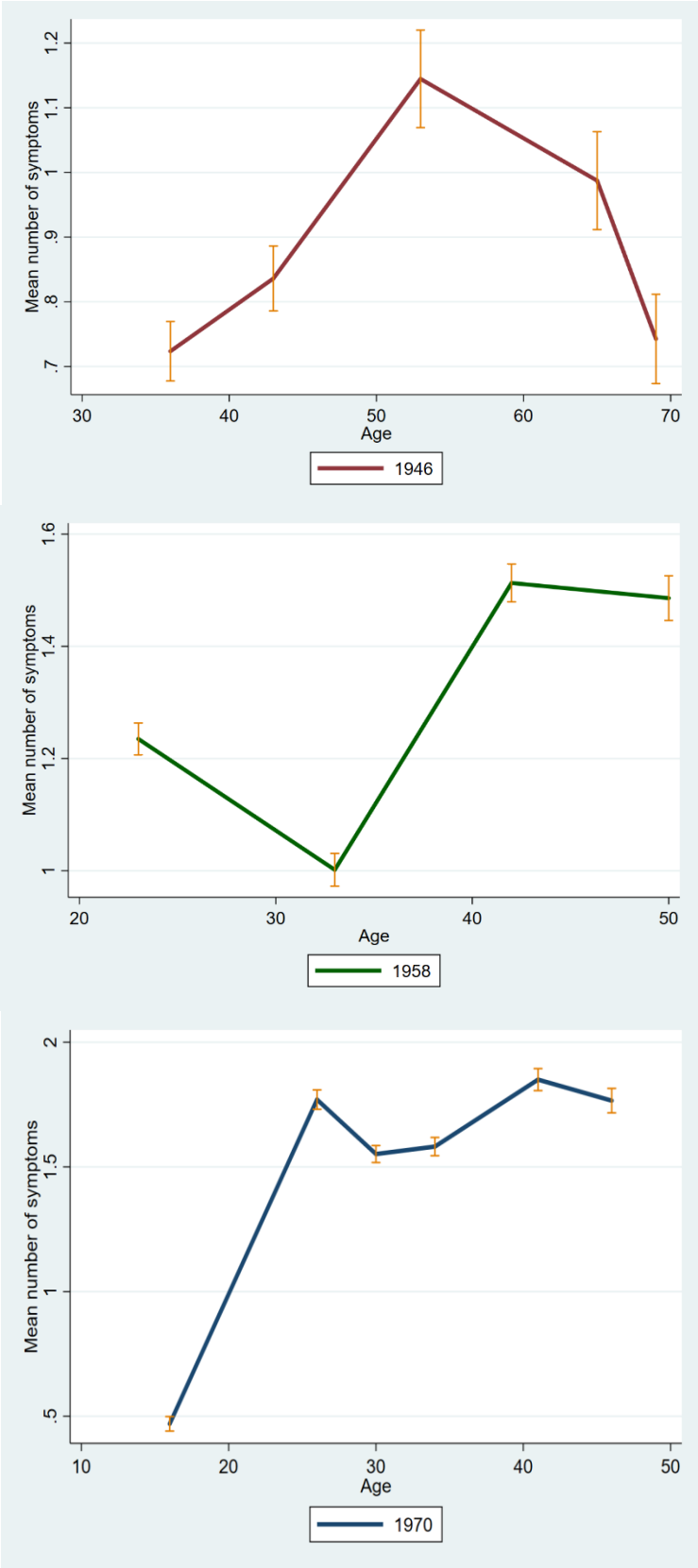
eTable 6. Comparable items across measures of psychological distress.

	Present State Examination	Psychiatric Symptom Frequency Questionnaire	General Health Questionnaire	Malaise Inventory
Item 1	Do you keep reasonably cheerful or have you been very depressed or low spirited recently?	Over the last year have you been in low spirits or felt miserable?	Have you recently been feeling run down and out of sorts?	Do you often feel miserable or depressed?
Item 2	Have you been exhausted and worn out during the day or evening even when you haven't been working very hard?	Over the last year have there been days when you tired out very easily?	Have you recently been feeling in need of a good tonic?	Do you feel tired most of the time?
Item 3	Do you often feel on edge, keyed up, mentally tense or strained?	Over the last year have you felt on edge, keyed up or mentally tense?	Have you recently felt constantly under strain?	Are you constantly keyed up and jittery?
Item 4	Have you had times when you felt shaky or your heart pounded or you felt sweaty and you simply had to do something about it?	Over the last year have you been in situations when you felt shaky or sweaty or your heart pounded or you could not get your breath?	Have you recently been getting scared or panicky for no good reason?	Does your heart often race like mad?
Item 5	What is it like when you worry?	Over the last year have you been so caught up in your own thoughts that you neglected things?	Have you recently found everything getting on top of you?	Do you often get worried about things?
Item 6*	How do you see the future?	Over the last year have you had the feeling that the future does not hold much for you?	Have you recently felt that life is entirely hopeless?	
Item 7*	What about your interests, have they changed at all? Have you lost interest in work, hobbies recreations/ let your appearance go?	Over the last year have you seemed to lose interest in things?	Have you recently been able to enjoy your normal day-to-day activities?	
Item 8*	Do you tend to brood on things? So much that you neglect your work?	Looking back over your adult life have nervous or emotional troubles ever stopped you from working or doing domestic chores or having social contacts	Have you recently found at times you couldn't do anything because your nerves were too	

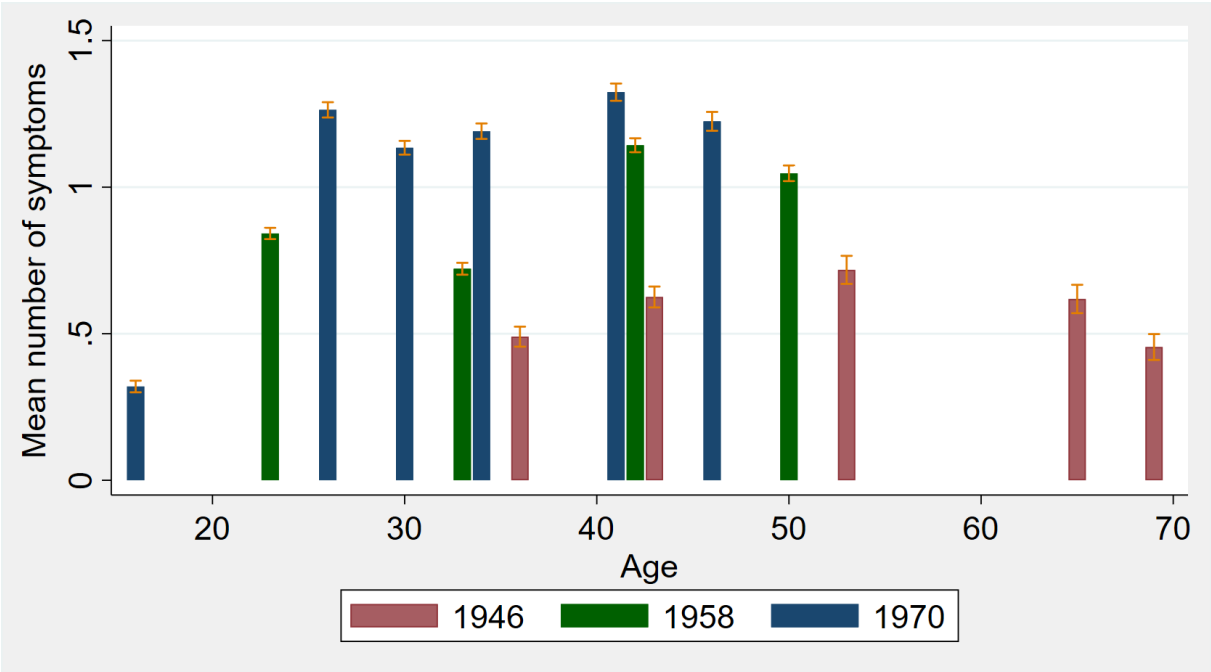
Item 9*	Do you tend to worry over your physical health?	for a fortnight or longer? Over the last year have you been frightened or worried about becoming ill or about dying?	bad? Have you recently felt that you are ill?	
Item 10*	Have you had any trouble getting off to sleep in the last month?	Over the last year have you had trouble getting off to sleep?	Have you recently lost much sleep over worry?	
Response options	Symptom not present/ Symptom definitely present during past month, but of moderate clinical intensity/ Intense form of symptom present for more than 50% of past month	Never/ Occasionally/ Sometimes/ Quite often/ Very often/ Always	Not at all been feeling in need of a good tonic?)/ No more than usual/ Rather more than usual/ Much more than usual	No/Yes
Cronbach`s alpha	0.58	0.65	0.75 – 0.81	0.52 – 0.73
Pearson`s r	0.80	0.80	0.87 – 0.89	0.91 – 0.95

*Additional items used for investigating age effects on psychological distress within 1946.

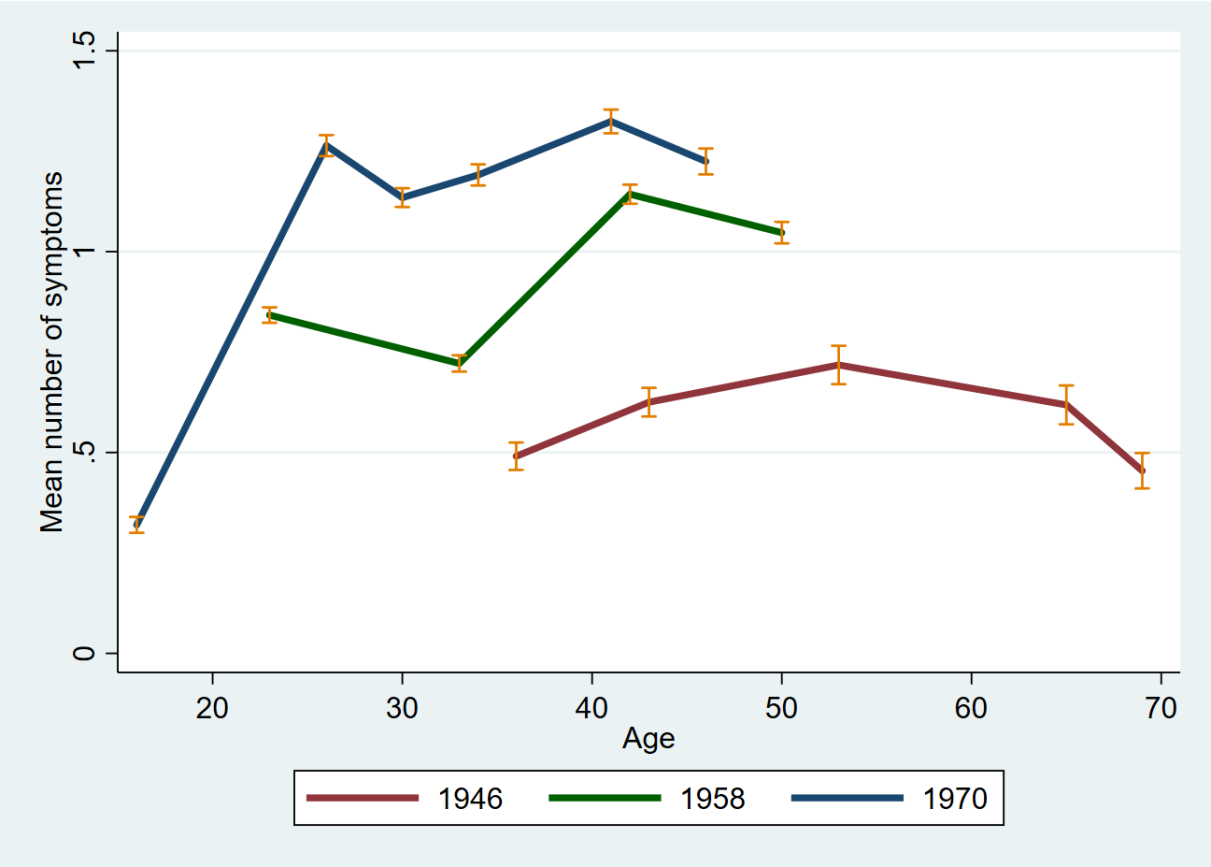
eFigure 1. Mean number of symptoms based on items comparable within cohorts: 1946 (ten items), 1958 (nine items), 1970 (nine items).



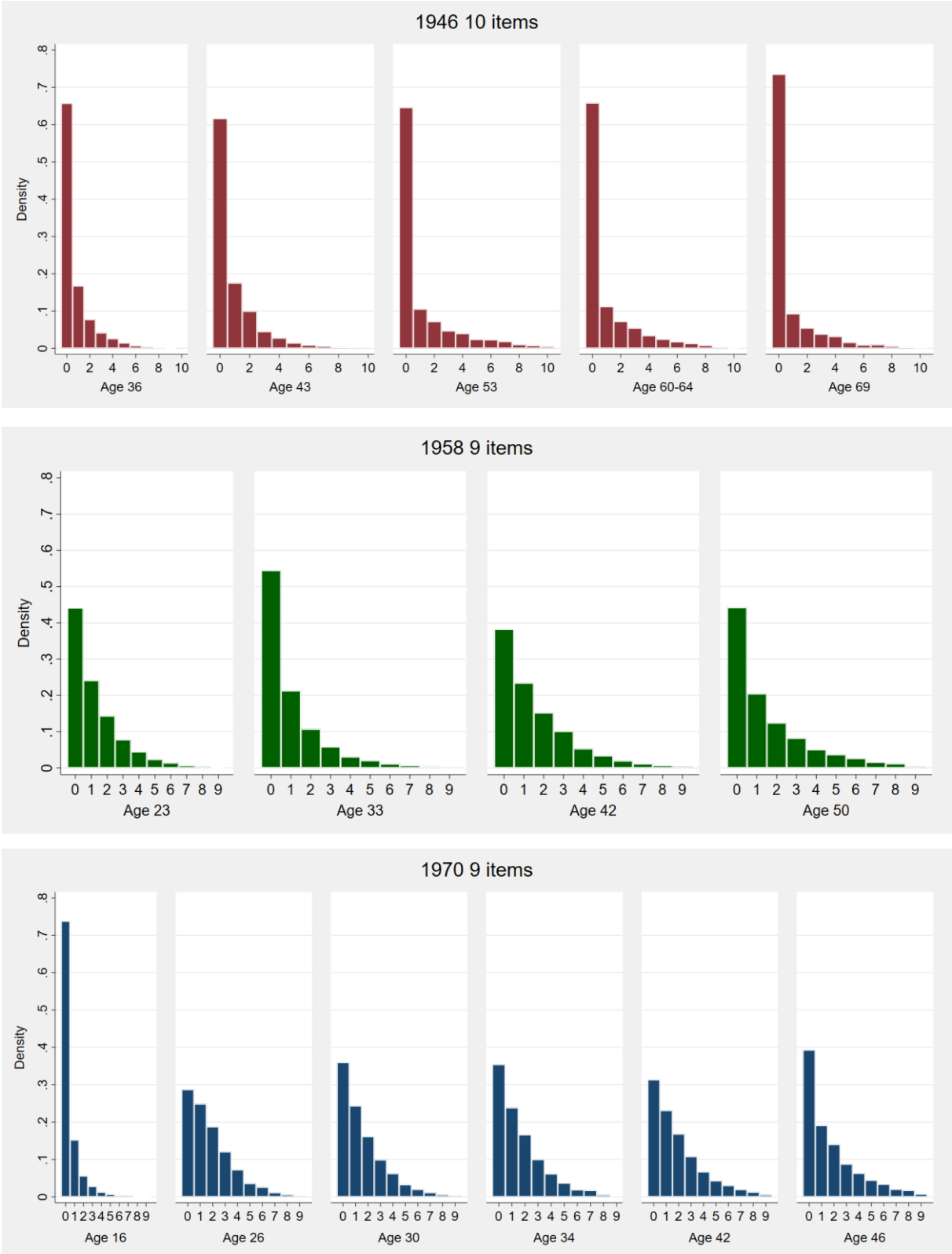
eFigure 2a. Mean number of symptoms based on five comparable items within and across cohorts.



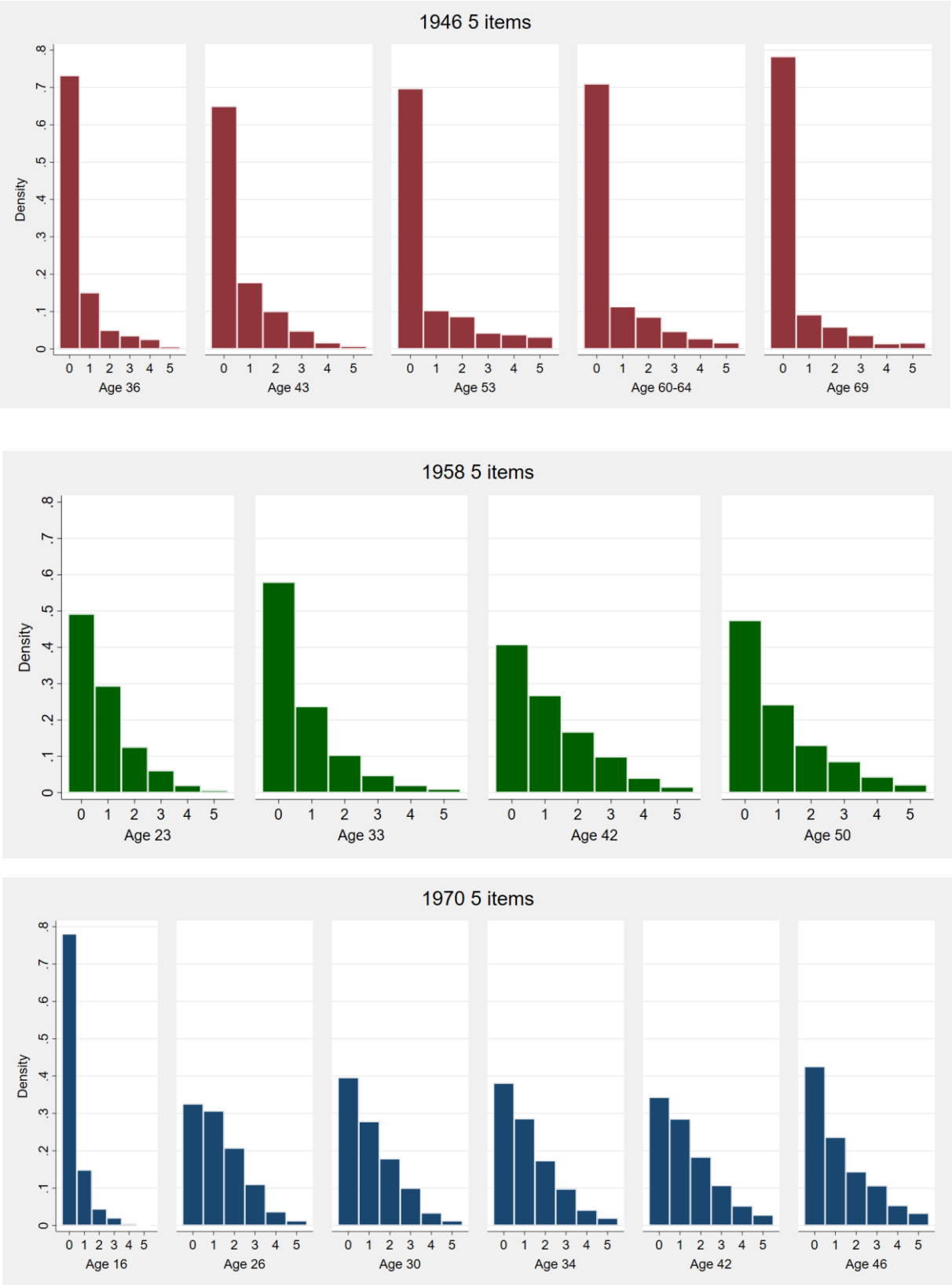
eFigure 2b. Mean number of symptoms based on five comparable items within and across cohorts.



eFigure 3. Distribution of symptoms based on items comparable within cohorts: 1946 (ten items), 1958 (nine items), 1970 (nine items).



eFigure 4. Distribution of symptoms based on five items comparable within and across cohorts.



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