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ORIGINAL PAPER

The age of anxiety? It depends where you look: changes in STAI trait anxiety, 1970–2010

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Abstract
Purpose Population-level surveys suggest that anxiety has been increasing in several nations, including the USA and UK. We sought to verify the apparent anxiety increases by looking for systematic changes in mean anxiety questionnaire scores from research publications.
Methods We analyzed all available mean State–Trait Anxiety Inventory scores published between 1970 and 2010. We collected 1703 samples, representing more than 205,000 participants from 57 nations.
Results Results showed a significant anxiety increase worldwide, but the pattern was less clear in many individual nations. Our analyses suggest that any increase in anxiety in the USA and Canada may be limited to students, anxiety has decreased in the UK, and has remained stable in Australia.
Conclusions Although anxiety may have increased worldwide, it might not be increasing as dramatically as previously thought, except in specific populations, such as North American students. Our results seem to contradict survey results from the USA and UK in particular. We do not claim that our results are more reliable than those of large population surveys. However, we do suggest that mental health surveys and other governmental sources of disorder prevalence data may be partially biased by changing attitudes toward mental health: if respondents are more aware and less ashamed of their anxiety, they are more likely to report it to survey takers. Analyses such as ours provide a useful means of double-checking apparent trends in large population surveys.

Keywords Anxiety · Mental health · Psychiatric epidemiology · Stigmatization of mental health problems

Introduction

Spielberger et al. [1] suggested that we are living in an 'age of anxiety' and it is often claimed that people are more prone to anxiety now than they were previously [2–4]. This assumption is often based on societal changes such as increasing working hours or exposure to new media [5, 6]. Psychologists studying anxiety have implicated decreasing social connectedness resulting from changing family structure and increases in perceived threats such as crime and ill health [7]. Other changes in mental health, specifically in the USA, have been associated with changes toward more materialistic goal setting, unrealistic expectations, and individualism [8]. On the other hand, many industrial nations have seen decreasing death rates and improving public health in recent decades [9]; typically, their citizens are better off now, in terms of amenities, ease of communication, and access to information than they have ever been. Therefore, there are as many reasons to expect anxiety to have decreased as there are to expect it to have increased.

In some nations, data suggest that anxiety has indeed increased. Large-scale surveys [10, 11] suggest that the prevalence of (not necessarily diagnosed) anxiety in the USA

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increased 5.23 % between 1990–1992 and 2001–2003. Surveys in the UK found that anxiety increased 12.8 % between 1993 and 2007 [12, 13], and UK physicians' records show increased anxiety diagnoses [14]. Similar increases have been found in Japan [15, 16], New Zealand [17], and Lebanon [18].

Increasing anxiety vulnerability is an important problem, because anxiety has been linked to other health issues, particularly depression [e.g., 19]. It may also necessitate absence from work, so anxiety has economic consequences [20, 21]. Since these effects should influence policy making, it is important to verify the survey findings.

One problem with health surveys is that they involve an in-person interview. Apparent increases in anxiety may partly reflect greater reporting of psychiatric problems to interviewers. This concern is nontrivial, given increasing awareness of mental health issues in recent decades [22] and a known tendency to underreport psychiatric problems [23, 24].

If anxiety really is increasing, this should be apparent in research publications: mean anxiety scores would be higher in more recent publications. The most commonly used [25, 26] measure of anxiety is the State–Trait Anxiety Inventory (STAI) [1, 27]. This assesses both state anxiety (the examinee's anxiety at the moment they complete the scale) and trait anxiety (the examinee's anxiety 'generally in [their] life', i.e., "anxiety-proneness as a personality trait"; [1], p. 4), where anxiety is defined as "tension, apprehension, nervousness, and worry" [1, p. 4]. The STAI has been used in thousands of studies in more than 60 languages [1, 28], has good internal consistency, test–retest reliability and construct validity [28, 29], and discriminates psychiatric patients from healthy controls [1, 28], making it ideal for examining changes in anxiety over time. Importantly, it is a self-report measure, and the modal research practice is to assure participants that their responses are confidential. It therefore circumvents the validity concerns with surveys (although its discriminant validity has been questioned; see "Discussion"). It should be possible to verify the surveys' results by comparing the mean STAI anxiety scores from research publications published in different years.

This technique was largely developed by Twenge [e.g., 30], who calls it cross-temporal meta-analysis (CTMA). Twenge [7] conducted such analyses on STAI scores from USA samples, and found that anxiety increased between 1970 and 1993, congruent with Kessler's [10, 11] later surveys. However, Twenge's analysis was limited to undergraduates in conventional 4 year programs: this was intended to maximize sample homogeneity and increase statistical power. This participant group has the most data available, but does not represent the average American. Economic conditions for American students have changed differently from those of the general American population over the study period. USA economic performance has been generally good, characterized by GDP growth and falling unemployment between 1982 and 2000 [31]. Mortality rates decreased between 1970 and 2010, and out-of-pocket health expenditure fell since 1995 [9]. However, American education is very expensive, and tuition fees show disproportional inflation [32]. Debt on graduation has been steadily increasing since federal student loans were introduced in the 1980s, and national student debt passed 1 trillion dollars in 2012 [see 33]. American students might have more reason to be anxious in recent years than the rest of the population. We therefore sought to investigate whether Twenge's findings generalize to a more inclusive USA sample.

Furthermore, we wished to extend our analysis to other countries. Social and economic conditions vary widely between nations, but assessing anxiety changes is just as important for any country. Lastly, we wished to update Twenge's 1993 analyses: surveys suggest anxiety in the USA and UK was rising quickly in the 17 years between this date and our 2010 data collection [11, 13].

Therefore, our research question was whether STAI trait anxiety means increased since 1970, when the STAI was published. We focused on trait anxiety, which is closer to the long-term pathological anxiety assessed by health surveys; state anxiety is a transitory mood, which occurs naturally and adaptively in all individuals: state anxiety also fluctuates rapidly, which would add considerable error variance to our analysis. Our analysis includes all English language articles (from any country) reporting a mean STAI trait anxiety, which were available in June 2010. To our knowledge, ours is the largest such analysis attempted.

Method

Literature search

Literature search was conducted in June 2010; articles were collected during the next 4 years. PsycINFO, PsycARTICLES, and Academic Search Complete were searched using the terms 'Spielberger', 'STAI', and 'trait anxiety'. This returned more than 8000 hits. We collected only journal articles published in English. Only 122 articles were unavailable.

Inclusion criteria

Samples were included if: (1) They reported a mean trait anxiety score, using the standard trait anxiety scale. Translations were accepted if they used the original instructions and format. (2) Participants were adults (over 18 years old), as there are different versions of the STAI

for children. (3) Participants were not selected for psychiatric morbidity, or taking psychoactive medication. Most samples were not screened for morbidity or medication use; we included such samples on the assumption that their rates of morbidity or medication would probably reflect those of the general population. (4) Participants were not selected for their level of anxiety, or an obvious correlate such as depression, anger, happiness or extraversion. (5) Participants did not have any obvious reason to be anxious at the time of testing. Samples experiencing stress or pain, or awaiting a medical procedure or diagnosis were excluded. Pregnant women were excluded, since the demographic characteristics of this group have changed during the study period: we are grateful to an anonymous reviewer for recommending this.

Sample characteristics (variables of interest)

Mean and, where available, standard deviation trait anxiety was recorded. We noted the participant type (e.g., students, hospital staff, general public) where available. Following Twenge [7], we coded year of data collection as 2 years before publication, unless a year was stated. We also included, where available, participants' mean age in years; sex, coded as the percentage of the sample that was female; and education in years, and students were assumed to have completed 1 year of study plus their normal compulsory education. When indicated, the proportion of non-Caucasian participants in the USA, UK, Canadian and Australian samples was also recorded. Unfortunately, more detailed ethnicity information is typically not reported.

Beck Depression Inventory scores were recorded where available. Beck and colleagues [34–36] have revised the scale twice; analyzing these three forms separately did not greatly change our results. We included depression because anxiety and depression are strongly correlated/comorbid and we wished to check whether apparent changes in anxiety were independent of changes in depression [37]. Depression was not controlled in all analyses: we compared regression models that did and did not control depression, looking for discrepancies (see "Analytic Strategy"). Several studies have suggested the STAI is sensitive to depression [e.g., 38, see "Discussion"], so controlling it improves the validity of our analyses.

Analytic strategy

Please see Online Resource 1 for additional details of our analyses. Mean anxiety scores were analyzed using weighted least-squares regression, weighting each sample's mean by its size. We analyzed a series of models, predicting trait anxiety from date of data collection, while controlling for covariates such as age, sex, education, ethnicity, and depression. Since most samples did not have all these data available, different models were run on different portions of the complete dataset. Limiting analyses to samples with all covariates available necessitates excluding too many data.

We report several effect size indexes. The regression coefficient B is the mean increase in STAI trait score per year. The standardized coefficient β is also given. Following Twenge et al. [8], a variation of d is given, equal to the change in predicted score during the study period divided by the mean sample SD. Our analyses have differing date ranges: to avoid confusion, we report the d extrapolated over the entire 40 year study period.

Subgroups

One problem with CTMA is that, because the samples are typically not random samples from the population, they can be unpredictably heterogeneous. One remedy is to use samples from a restricted population, such as students [e.g., 7, 8]. We first analyzed all data and then replicated our analyses with samples of a certain type (e.g., students, community volunteers) wherever sufficient data were available. Where results differ from results from the entire dataset, this is reported.

Form X and Form Y

The STAI was substantially revised in 1983 (from 'Form X' to 'Form Y'); six of the 20 items were replaced to improve the scale's factor structure and discrimination between anxiety and depression. We addressed this issue in two ways. Firstly, we ruled out mean differences in scores on the two forms by examining the effect of controlling STAI form in our regression models. Secondly, where sufficient data were available, we analyzed the two forms' data separately.

Results

Sample characteristics

The dataset included 1703 samples from 1247 publications, and represented 205,451 participants from 57 nations. The samples' mean ages ranged from 18 to 83 ($M = 31.40$); the mean sample had 57.46 % female, with 13.84 years of education. The most common participant groups were students (696 samples) and unselected general public (235 samples).

We present the analyses of the full dataset, followed by those from the USA, UK, Canada and Australia, since these nations had the most complete data (studies conducted in

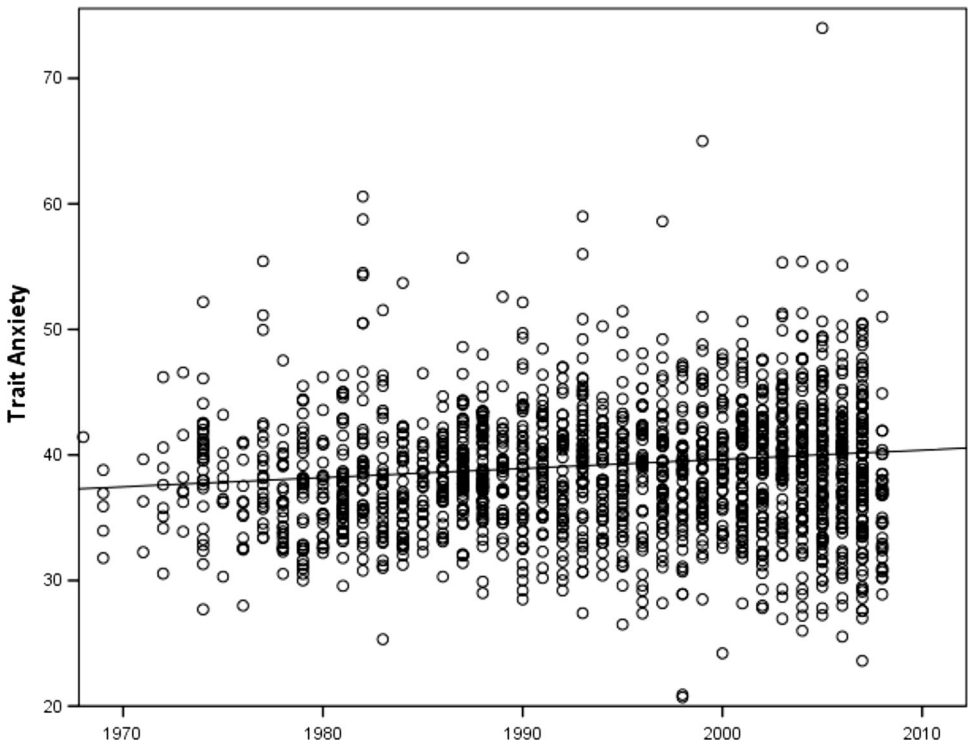

Fig. 1 Worldwide dataset, showing a significant increase in anxiety. STAI trait anxiety scores can vary between 20 and 80. Fit line is weighted by the size, *N*, of each sample in the dataset

these nations were most likely to have been published in English). See Online Resource 1 for a list of included nations and analyses of more individual nations' data.

Worldwide data

Date significantly predicted trait anxiety [$B = 0.073$, $\beta = 0.157, 95\ \%\ \mathrm{CI}\ (0.109, 0.205), t = 6.55, p < 0.001$, see Fig. 1; $d = 0.343$; one sample excluded, Cook's distance = 12.08[1]]. This relationship remained significant controlling for STAI form [$\beta = 0.174$, 95 % CI (0.120, 0.228), $p < 0.001$, 1508 samples], age [$\beta = 0.119$, 95 % CI (0.065, 0.173), $p < 0.001$, 1213 samples], sex [$\beta = 0.145$, 95 % CI (0.095, 0.195), $p < 0.001$, 1524 samples], education [$\beta = 0.114$, 95 % CI (0.050, 0.178), $p < 0.001$, 939 samples] and depression [$\beta = 0.111$, 95 % CI (0.019, 0.203), $p = 0.016$, 381 samples]. This trend was clear in students [$\beta = 0.260$, 95 % CI (0.187, 0.333), $p < 0.001$, $d = 0.456$, 696 samples] and non-students [$\beta = 0.153$, 95 % CI (0.091, 0.215), $p < 0.001$, $d = 0.351$, 1006 samples]. The increase was clear in undergraduate students [medical, nursing, therapy, mature, community/open university, and graduate students were excluded; $\beta = 0.185$, 95 % CI (0.089, 0.281), $p < 0.001$, $d = 0.294$, 403 samples] and in unselected community volunteers [$\beta = 0.130$, 95 % CI (0.002, 0.258), $p = 0.047$, $d = 0.260$, 235 samples].

Since there is a difference in content between Forms X and Y of the STAI, we analyzed them separately. The increase in scores was larger with Form X [$\beta = 0.205$, 95 % CI (0.141, 0.269), $p < 0.001$, $d = 0.441$, 935 samples; date range 1968–2008] than with Form Y [$\beta = 0.093$, 95 % CI (0.009, 0.177), $p = 0.026$, $d = 0.226$, 573 samples; date range 1981–2008].

USA

In the USA (686 samples, $N = 80{,}237$; date range 1968–2008), there was an increase in anxiety [$B = 0.047$, $\beta = 0.127$, 95 % CI (0.051, 0.203), $t = 3.34$, $p = 0.001$, see Fig. 2; $d = 0.218$]. This remained significant controlling for the STAI form [$\beta = 0.112$, 95 % CI (0.020, 0.204), $p = 0.014$, 643 samples], sex [$\beta = 0.123$, 95 % CI (0.041, 0.205), $p = 0.003$, 608 samples] and education [$\beta = 0.142$, 95 % CI (0.050, 0.234), $p = 0.002$, 430 samples], but not when controlling for depression [$\beta = 0.066$, 95 % CI (−0.082, 0.214), $p = 0.372$, 160 samples]. This increase was only apparent in the student samples [$\beta = 0.248$, 95 % CI (0.144, 0.352), $p < 0.001$, $d = 0.371$, 333 samples]; it was absent in the non-student samples [$\beta = 0.067$, 95 % CI (−0.039, 0.173), $p = 0.212$, $d = 0.099$, 353 samples]. The increase was also only apparent in Form Y [$\beta = 0.164$, 95 % CI (0.038, 0.290),

[1] This and some other samples in subsequent analyses are excluded because of their size; here, $N = 11{,}336$. Although a larger sample may provide a more accurate estimate of the population mean, its large weight in the models can distort the time's effects. Including this case does not change the results.

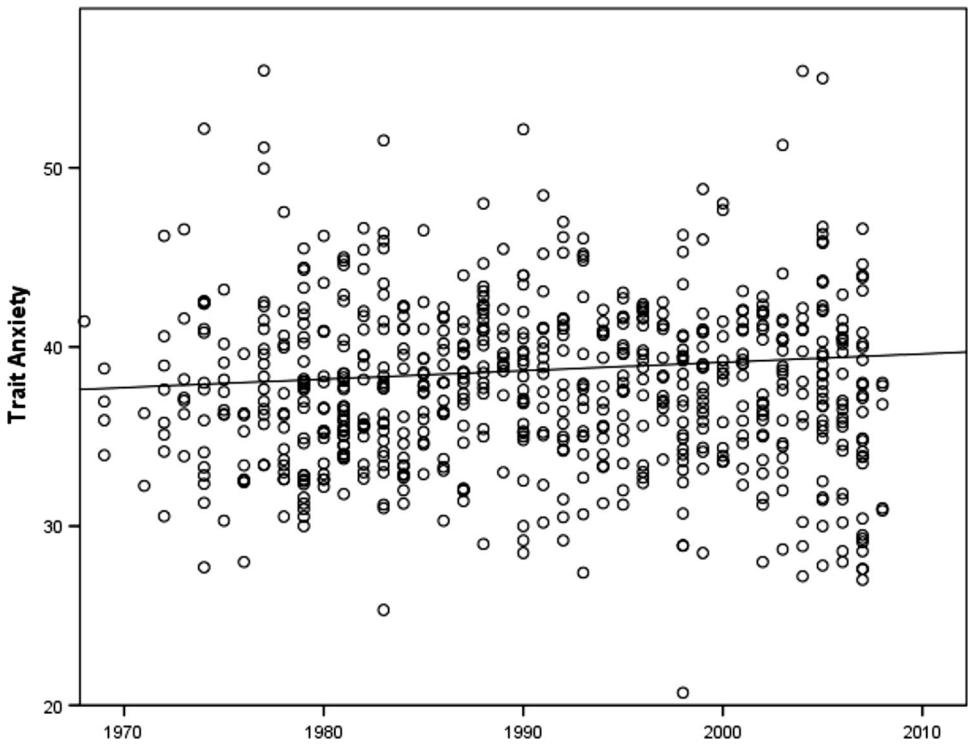

Fig. 2 USA data. The increase in anxiety is significant, but only among student samples

$p = 0.010$, $d = 0.313$, 247 samples, date range 1981–2008], and not in Form X [$\beta = 0.028$, 95 % CI (−0.072, 0.128), $p = 0.578$, $d = 0.058$, 395 samples, date range 1968–2007].

Finally, we analyzed just undergraduate students, extending Twenge's [7] original study. We replicated her significant increase in anxiety [$\beta = 0.279$, 95 % CI (0.145, 0.413), $p < 0.001$, $d = 0.379$, 204 samples], and this was robust to controlling our covariates.

UK

In the UK (147 samples, $N = 9144$, date range 1980–2008), there was evidence of a decrease in anxiety over time [$B = -0.110$, $\beta = -0.174$, 95 % CI (−0.338, −0.010), $t = -2.12$, $p = 0.035$, see Fig. 3; $d = -0.495$]. This remained significant when controlling the STAI form [$\beta = -0.196$, 95 % CI (−0.386, −0.006), $p = 0.042$, 132 samples] and sex [$\beta = -0.349$, 95 % CI (−0.517, −0.181), $p < 0.001$, 128 samples]. This decrease was present among non-students [$\beta = -0.200$, 95 % CI (−0.412, 0.012), $p = 0.064$, $d = -0.569$, 87 samples], but not among students [$\beta = -0.079$, 95 % CI (−0.341, 0.183), $p = 0.548$, $d = -0.205$, 60 samples; in undergraduates only, $\beta = -0.336$, 95 % CI (−0.741, 0.070), $p = 0.101$, $d = -0.963$, 25 samples]. When just the Form X data were examined, the decrease was not significant [$\beta = -0.203$, 95 % CI (−0.479, 0.073), $p = 0.149$, $d = -0.659$, 52 samples, date range 1980–2007]; the same was true for the Form Y data [$\beta = -0.140$, 95 % CI (−0.364, 0.084), $p = 0.214$, $d = -0.397$, 80 samples, date range 1988–2008].

Canada

In Canada (93 samples, $N = 9934$, date range 1974–2007), there was some evidence of an increase in anxiety over time [$B = 0.071$, $\beta = 0.221$, 95 % CI (0.017, 0.425), $t = 2.16$, $p = 0.033$, see Fig. 4; $d = 0.331$], but this was not significant when controlling the STAI form [$\beta = 0.048$, 95 % CI (−0.248, 0.344), $p = 0.745$, 89 samples] or sex [$\beta = 0.208$, 95 % CI (−0.006, 0.422), $p = 0.055$, 87 samples]. The increase was larger, though non-significant, in students [$\beta = 0.248$, 95 % CI (−0.040, 0.536), $p = 0.089$, $d = 0.231$, 48 samples; in undergraduates only, $\beta = 0.274$, 95 % CI (−0.057, 0.605), $p = 0.100$, $d = 0.217$, 37 samples] and absent in non-students [$\beta = 0.034$, 95 % CI (−0.274, 0.339), $p = 0.826$, $d = 0.080$, 44 samples, one sample excluded, Cook's distance = 3.08].

Both the Form X scores [$\beta = 0.083$, 95 % CI (−0.171, 0.337), $p = 0.513$, $d = 0.197$, 64 samples, date range 1974–2004] and the Form Y scores [$\beta = -0.077$, 95 % CI (−0.493, 0.339), $p = 0.715$, $d = -0.135$, 25 samples, date range 1990–2007] showed no change in anxiety over time, although the latter analysis was underpowered.

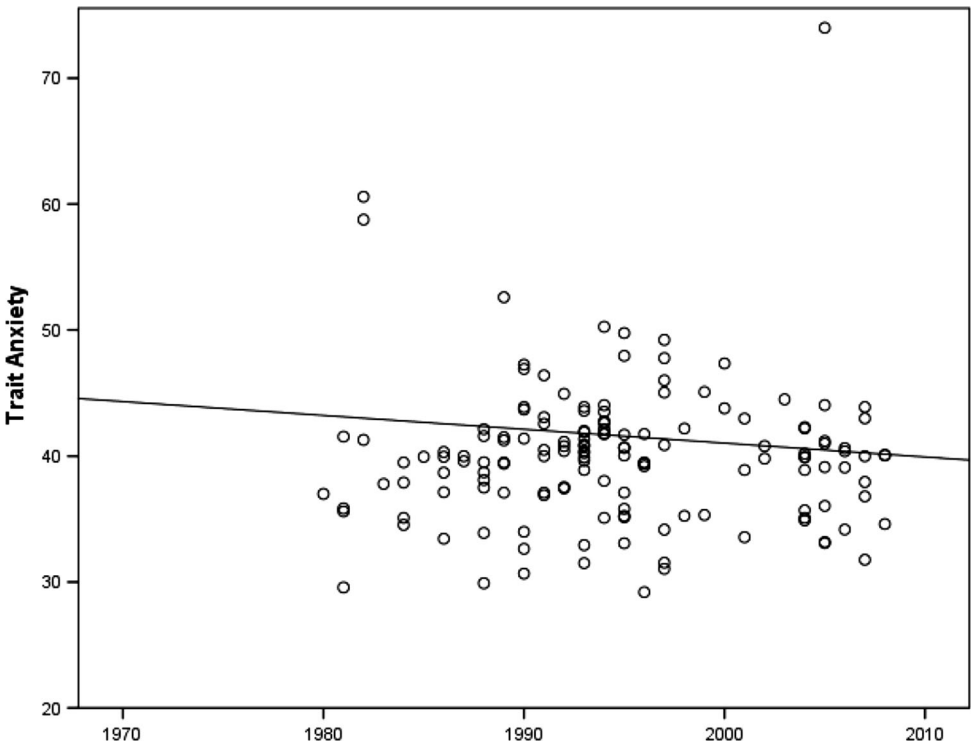

Fig. 3 UK data, showing a significant decrease in anxiety

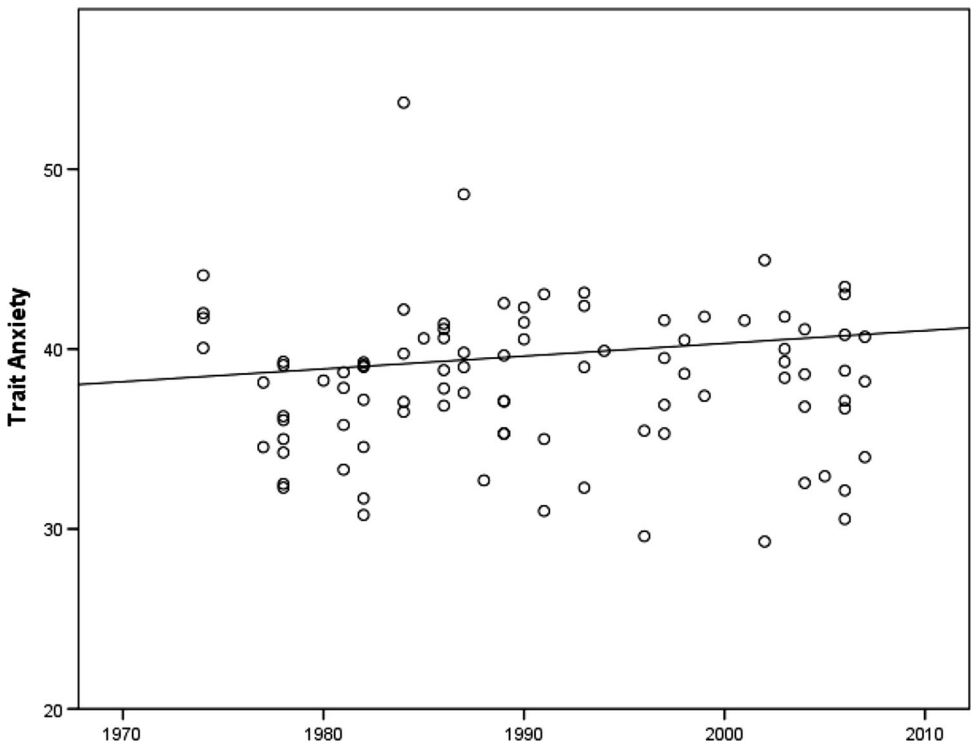

Fig. 4 Canada data. Increase in anxiety is significant, but not when controlling for sex

Australia

In Australia (87 samples, $N = 8867$, date range 1976–2008; one sample excluded, Cook's distance = 2.58), there was no evidence of any change in anxiety over time [$B = 0.046$, $\beta = 0.089, 95\ \%\,\mathrm{CI}\,(-0.127, 0.305), t = 0.824, p = 0.412$, see Fig. 5; $d = 0.209$]. There was no change in student [$\beta = -0.134$, 95 % CI (-0.510, 0.242), $p = 0.473$,

$d = -0.231$, 31 samples; undergraduates only, $\beta = -0.195$, 95 % CI (−0.652, 0.262), $p = 0.385$, $d = -0.237$, 22 samples] or non-student subgroups [$\beta = 0.121$, 95 % CI (−0.149, 0.391), $p = 0.374$, $d = 0.281$, 56 samples]. There was also no change in anxiety when Form X [$\beta = -0.061$, 95 % CI (−0.409, 0.287), $p = 0.726$, $d = -0.140$, 35 samples, date range 1976–2008] and Form Y [$\beta = 0.065$, 95 % CI (−0.229, 0.359), $p = 0.660$, $d = 0.213$, 48 samples, date range 1985–2008] data were analyzed separately.

Rest of the world

Finally, we examined data from the 53 remaining nations (688 samples, $N = 85{,}539$, date range 1969–2008). There was a clear increase in anxiety over time [$B = 0.128$, $\beta = 0.218$, 95 % CI (0.144, 0.292), $t = 5.85$, $p < 0.001$, $d = 0.616$], which remained significant controlling for age [$\beta = 0.200$, 95 % CI (0.116, 0.284), $p < 0.001$, 512 samples], sex [$\beta = 0.213$, 95 % CI (0.135, 0.291), $p < 0.001$, 620 samples] and depression [$\beta = 0.236$, 95 % CI (0.080, 0.392), $p = 0.003$, 121 samples]. This increase was visible in student samples [$\beta = 0.291$, 95 % CI (0.163, 0.419), $p < 0.001$, $d = 0.646$, 224 samples] and non-student samples [$\beta = 0.203$, 95 % CI (0.111, 0.295), $p < 0.001$, $d = 0.588$, 464 samples], but not in undergraduates [$\beta = 0.118$, 95 % CI (−0.068, 0.304), $p = 0.209$, $d = 0.239$, 115 samples]. This increase was only visible in the Form X data [$\beta = 0.304$, 95 % CI (0.208, 0.400), $p < 0.001$, $d = 0.794$, 388 samples, date range 1969–2008] and there was no significant increase in the Form Y data [$\beta = 0.082$, 95 % CI (−0.070, 0.234), $p = 0.287$, $d = 0.251$, 172 samples, date range 1986–2008].

Discussion

Our results show a worldwide increase in STAI trait anxiety since 1970; however, this increase was not visible within all individual nations. Of particular interest are the USA and UK, which have most data available and have suffered dramatic increases in anxiety according to their national surveys [11, 13]. In the USA, increases in STAI trait anxiety were limited to students. In the UK, there was a significant decrease in STAI trait anxiety. There is therefore a discrepancy between those surveys and these data from the literature.

Worldwide, there was a significant increase in STAI trait anxiety; scores increased one point every 13.70 years. This means that approximately 59 % of respondents in 2008 scored above the mean for respondents in 1968, a substantial and clinically important change. There was a similar increase in the data once those from the USA, UK, Canada and Australia were removed. This seems to support the hypothesis that changing working conditions, norms and media practices impact the mental health of ordinary citizens around the world to a measureable extent

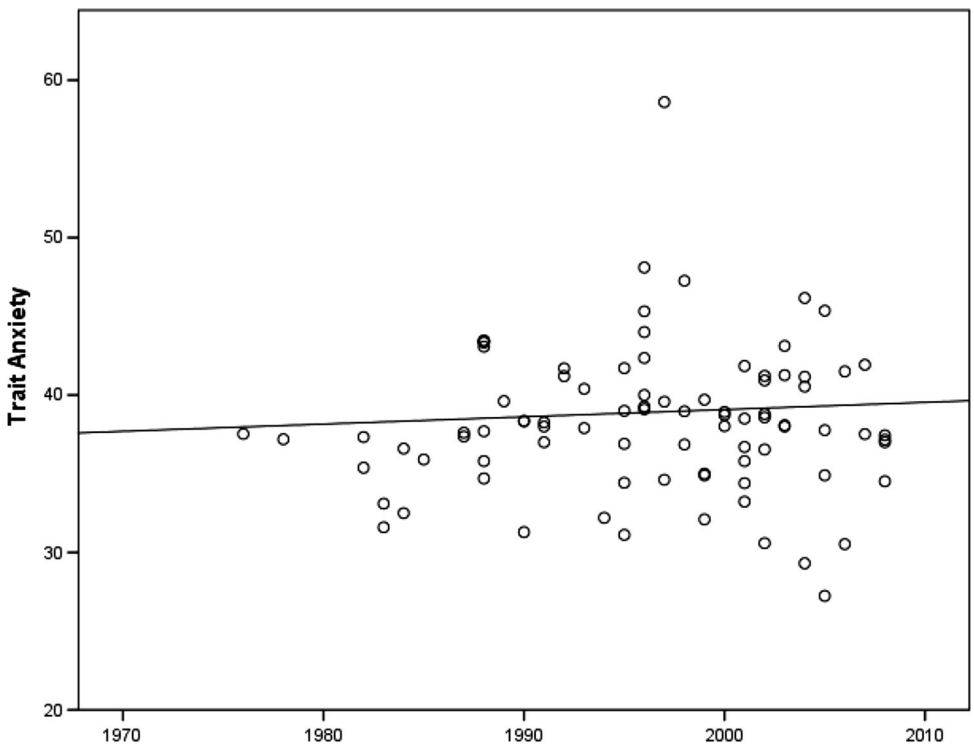

Fig. 5 Australia data, showing no change in anxiety

[e.g., 5, 7, 6]. As new media facilitates communication across national boundaries, changes in expectations, motivations and opinions are increasingly likely to generalize across the globe. Of course, economic variables still vary by country, but Twenge [7] reported that anxiety variations in American students were more closely linked to social variables than they were to economic factors: in the present dataset there does not seem to be a simple relationship between the extent of a nation's economic development and changes in anxiety (see Online Resource 1 for further analyses of individual nations' data).

With analyses such as these, it is typical to focus on a particular participant group to maximize sample homogeneity: here we simply analyzed all available data, so the fact that significant increases appeared in spite of sample heterogeneity seems to suggest an increase is genuinely present. However, this heterogeneity may bias the results: although the increase remained significant in models controlling various covariates and also in analyses of more homogeneous sample groups, only three nations we studied (USA, Japan and Turkey; see Online Resource 1) showed convincing increases, while two nations (UK and The Netherlands) showed decreases. Analyzing grouped data may be less informative than analyzing data from individual countries.

Given the survey data, we would expect to see clear STAI trait anxiety increases in the USA and UK. The fact we do not is surprising. We do not claim that our data are more valid than the surveys. Our data are not representative of the general public: students, university and hospital staff, and university town residents are overrepresented. However, these groups are consistently overrepresented during the period studied. So, these data cannot accurately estimate the mean anxiety level of a nation, but they can index changes in anxiety over time.

We suggest surveys have registered increases in anxiety partly because people have grown better at recognizing and/or reporting psychiatric symptoms [22]. Partly, this will have occurred as a result of improving symptom identification and diagnostic criteria, and refinements to assessment tools. But it may also reflect a greater willingness of respondents to share details of their mental health issues with interviewers. Although social desirability may affect the confidential pen-and-paper STAI, this should be more of a problem for interview-based surveys [10, 11, 13]; any decrease in social desirability concerns should lead to a larger increase in interview-assessed anxiety than it does in STAI-assessed anxiety. Congruently, Twenge and Im [39] found American college students' social desirability concerns decreased between 1958 and 1980: this was not associated with STAI scores, consistent with the STAI being less vulnerable to social desirability. While MacKenzie and colleagues' [40] CTMA suggested that American students' attitudes toward seeking treatment became more negative between 1968 and 2008, they suggest that this applies mainly to 'talk' psychotherapy; Americans' willingness to seek pharmacotherapy for psychiatric problems has increased according to health surveys [11] and the General Social Surveys [41]. If citizens are indeed becoming more aware and less ashamed of mental health problems, this is beneficial. Anxiety remains a large problem, but greater awareness and destigmatization may mean fewer people leave their symptoms untreated [42].

In the USA and Canada, there was some evidence of a STAI anxiety increase, but this was limited to students. This may be because college students form more homogeneous groups than do other research participants, and so analyses of students have lower error variance. We cannot endorse this account, because only non-student samples showed significant time effects in our UK data. Alternatively, students perhaps have had more reason to experience more anxiety than the general population. Economic conditions in the USA have been generally good for the period studied [9, 31], but tuition fees and student debt increased dramatically [32, 33]. Exaggerated increases in anxiety among the student population are therefore expected. Anxiety increases in American and Canadian students are potentially serious—our results suggest approximately 64 % of American students in 2008 scored above the mean for 1968—but may not indicate population-wide anxiety increases. While Twenge and colleagues' [8] CTMA also revealed an increase in American adolescents' psychopathology between 1951 and 2002, this analysis was based on only 14 samples and requires verification.

In the UK, STAI trait scores decreased one point every 9.09 years on average, and this decrease was apparently limited to non-students. While more people are being treated for anxiety in the UK [14], this may not mean that people are more anxious: it might be that people are more likely to seek treatment. Although tuition fees have skyrocketed, this largely happened after 2010, the end of our study period. It may therefore be unsurprising that UK students do not show the same STAI score increases as USA students.

Our results are important for two reasons. Firstly, our work bolsters that of Twenge and others [7, 8, 37] in showing that CTMAs can usefully estimate time-related trends. While organized surveys have considerable advantages, comparing two surveys conducted at different times can be complicated due to changes in diagnostic criteria and methodology. Official surveys may also be more vulnerable to biased responding. CTMAs provide a useful means of verifying apparent changes.

Secondly, our results add to the information available for governmental and health organizations. Anxiety is a

public health and economic problem [21], and an adequate understanding of its epidemiology is crucial. For example, if the increases in American anxiety are restricted to students, this does not mean that they are unimportant: indeed, these data suggest a dramatic and harmful increase in anxiety in this group. The next generation of American professionals is not just being saddled with greater debt, but they are also being saddled with greater emotional distress and vulnerability to health problems. This is likely to impact the country's economic performance long into the future.

One issue with our analyses concerns the validity of the STAI Trait Anxiety Scale. Several authors have questioned its factor structure [43, 44] and emphasis on cognitive rather than somatic anxiety [cf. 45]; importantly, studies have found that the scale is sensitive to depression [38, 44] and negative affect [46]. We chose the STAI because more data are available from this instrument than from any other [25, 26], its reliability is good, and it is applicable to varied study populations [28]. It is possible that depression has influenced our findings, but we believe this is unlikely: statistically controlling for depression did not alter our results. Relatedly, the STAI's content revision from Form X to Form Y complicates the interpretation of these data. We controlled for STAI form within every nation's data, in case the population means for the two forms were different, and where sufficient data were available we analyzed the two forms separately. However, for nations and subgroups with less data available, it should be remembered that different sensitivities of the two forms may bias the results.

Another issue with this study is its reliance on under-specified heterogeneous samples. This problem affects any review or meta-analysis. We addressed it by replicating our primary analyses while controlling for various socio-demographic variables and by replicating our analyses in more homogeneous subgroups of our dataset. Where such analyses do not produce contradictory results, this suggests that sample heterogeneity does not strongly influence the analyses. It would be ideal to analyze samples that are restricted to age or other demographic variables, but, with the arguable exception of students, such samples are not numerous enough for multiple regression models.

To summarize, CTMAs provide a useful tool for confirming trends in health surveys. Our analyses suggest that anxiety may be increasing worldwide, but not as rapidly as previously thought in the USA and UK. When interpreting trends in survey data, it is important to also assess changes in awareness and reporting of mental health problems. While anxiety constitutes a severe public health problem in the nations studied, it might not be increasing very dramatically except in populations experiencing increasing personal or economic hardships, such as American students.

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Compliance with the ethical standards

Ethical standards This manuscript does not contain original clinical studies or patient data.

Conflict of interest The authors declare that they have no conflict of interest.

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