Title: Resilience moderates the association between chronic pain and depressive symptoms in the elderly

Running head: Pain, depression, and resilience in the elderly

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Submission category: Original article

Funding: The KORA research platform was initiated and financed by the Helmholtz Zentrum München, which is funded by the German Federal Ministry of Education and Research and by the State of Bavaria. The KORA-Age project was financed by the German Federal Ministry of Education and Research (BMBF FKZ 01ET0713 and 01ET1003A) as part of the 'Health in old age' program. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Conflicts of interest: None declared

What does this study add?

- This is one of the first studies to investigate the effects of psychological resilience on the relation between pain and depressive symptoms in the elderly general population
- Resilience attenuates the association of chronic widespread pain with depressive symptoms

Abstract

Background

Chronic pain is frequent in elderly people and, especially if widespread, associated with poor mental health. We investigated whether a resilient personality protects older adults against the adverse effects of chronic pain.

Methods

Pain status (no pain, chronic local pain / CLP, chronic widespread pain / CWP) was determined using the American College of Rheumatologists' criteria for widespread pain in a cross-sectional sample of 724 participants aged 68 to 92 years drawn from the population-based KORA-Age study in Southern Germany. Depressive symptoms and resilience were assessed via the scales GDS-15 and RS-5. The relation between pain, resilience, and depressive symptoms was modeled using logistic and quantile regression.

Results

CLP and CWP prevalences were 57.5% and 12.3%, respectively. Confounder-adjusted logistic regression indicated a fourfold risk of depressed mood (GDS-15≥5) in CWP, vs. no pain (OR=4.08, 95% CI 1.90–8.74). However, in quantile regression, the adverse effect of CWP was significantly attenuated by resilience when looking at the GDS-15 score lower quartile (P=0.011) and median (P=0.011). This effect appeared to be mainly driven by participants aged 75 to 84 years. Confounder adjustment reduced the effect of CLP on depressive symptoms to non-significance, and effect modification by resilience was undetectable in regression models of CLP.

Conclusions

Resilience was protective in the association of CWP with depressive symptoms in this analysis. Older adults with CWP may potentially benefit from interventions supporting resilience. Prospective research should investigate the protective role of resilience in the potentially self-perpetuating relation between chronic pain and depressed affect.

Introduction

Chronic pain is a major public health burden for elderly populations. Its prevalence ranges between 25 to 65% in older adults living in the community and may exceed 80% in residential care (Gibson, 2007). In the general population, about 5 – 15% of men and 15 – 20% of women aged 65 years or higher (Croft et al., 1993; Bergman et al., 2001; Leveille et al., 2005; Häuser et al., 2012) are affected by chronic widespread pain (CWP), a particularly severe form of chronic pain which has been defined by the American College of Rheumatologists (ACR) as pain above and below the waist, in the right and left hand sides of the body, and in the axial skeleton which has been present for at least three months (Wolfe et al., 1990).

Chronic pain is associated with adverse mental health outcomes such as cognitive impairment (Landrø et al., 2013), depression and anxiety (Gerrits et al., 2014), and suicidality (Tang and Crane, 2006). Compared to individuals with chronic local pain (CLP), those suffering from CWP have more persistent pain, increased psychiatric symptom burden and fatigue and apply more often for disability pension (Nordeman et al., 2012; Viniol et al., 2013). In the elderly, CWP is associated more strongly than CLP with progression of disability (Leveille et al., 2001), depressed mood (Denkinger et al., 2014) and decreases in functioning and social participation (Wilkie et al., 2013).

Nonetheless, while chronic pain leads to depression and disability in some, others remain unaffected (Zhu et al., 2014). The concept of resilience offers a possible explanation of these differences (Sturgeon and Zautra, 2010). Resilience refers to a system's capacity to adapt to or recover from adversity. It is a dynamic, multifaceted construct operating on different but interacting levels (society, community, social networks, individuals, behavior, and intrapsychic processes) and domains (physical, psychological, financial, ecological, etc) of functioning (Wiles et al., 2012; Wild et al., 2013). Here, we will focus on the facet of individual, psychological resilience, which involves emotional flexibility and the availability of problem-solving strategies (Wagnild and Young, 1993; Waugh et al., 2011). In chronic pain, these resources may facilitate adaptive coping styles such as pain acceptance (Ramírez-Maestre and Esteve, 2014). Accordingly, psychological resilience has been shown to protect against the adverse effects of chronic pain on psychological adjustment (Ruiz-Párraga et al., 2015). However, due to unique life circumstances and associated life challenges in

advanced age (such as bereavement, loss of social roles, and illness; Hildon et al., 2008), resilience may operate differently in older, compared to younger adults (Duggleby et al., 2012; Hanfstingl, 2013).

It is therefore important to investigate the potentially moderating, protective role of psychological resilience within this particular group, in which chronic pain is highly prevalent. It is also unknown whether psychological resilience is equally protective in chronic pain conditions of different severity, such as CLP and CWP. The present analysis aimed to determine whether psychological resilience moderates the association of chronic pain with depressive symptoms in a population of community-dwelling older adults.

Methods

Participants, setting, and data sources

Data were derived from the KORA-Age cohort (Peters et al., 2011) which is based on all individuals born in 1943 or earlier who participated in the population-based MONICA / KORA surveys (Holle et al., 2005). In the four MONICA / KORA surveys conducted between 1984 and 2001, participants were randomly selected from population registries of the city of Augsburg and its two surrounding counties in Southern Germany. A physical examination was performed in a gender- and age-stratified random subsample of 1079 participants in 2009. In 2012, 822 of these participants took part in a follow-up examination (Fig. 1), which provides the data for this cross-sectional study.

Our analysis is based on 724 participants aged 68 to 92 years with complete data. Excluded participants (n = 98) differed most noticeably from complete cases in that they were on average older, less educated, less physically active and had higher depressive symptom scores as well as worse cognitive status. Full details of the comparison between included and excluded cases are presented in Supplementary Table S1.

The KORA-Age follow-up examination included an in-depth personal interview and a self-administered questionnaire. Additionally, a telephone interview was conducted shortly after the examination. If a participant was unable to visit the KORA study center, the examination took place at his/her home.

Quality control measures were coordinated centrally by the KORA study center and included a pilot study of the procedure, repeated training and certification of examiners, auditing by an external quality control committee, and cross-checking of raw against entered data. The KORA-Age studies were approved by the ethical review board of the Bavarian Medical Association ("Bayerische Landesärztekammer"), and written informed consent was obtained from the study participants.

Exposure variables

Pain status. In the self-administered questionnaire, participants were asked whether or not they experienced bodily pain "on a regular basis once or several times per week" and if yes, to indicate the location and extent of pain by drawing circular marks on manikins of the human body adapted from the "Deutscher Schmerzfragebogen" (German Pain Questionnaire; Nagel et al., 2002). No reference to a particular time frame over which the pain had to be present was made in the pain question. It was assumed that the wording of the question quoted above would rule out most cases of acute pain and could be considered chronic (i.e., pain lasting at least three months, according to the most widely used definition, IASP, 1986). Thus, the drawings were used to determine CWP according to the American College of Rheumatologists' 1990 criteria of CWP (Wolfe et al., 1990). Any participants reporting pain, but not satisfying these criteria were classified as having CLP.

Resilience. The Resilience Scale 5 (RS-5), a screening version of the German RS-11 scale (Schumacher, 2005), which is derived from Wagnild and Young's 25 item Resilience Scale (Wagnild and Young, 1993), was used to assess resilience in the telephone interview. The RS-5 consists of 5 items summed to a score ranging from 5 to 35. Missing item values were replaced by the mean of the remaining item scores.

The RS-5 was developed in a previous sample of older adults in the KORA-Age cohort, where it showed measurement invariance across gender and age groups, good internal consistency ($\alpha = 0.8$), and moderate correlations with symptoms of depression (r = -.34), anxiety (r = -.29), loneliness (r = -.33), and self-rated health (r = .21) (von Eisenhart Rothe et al., 2013). The RS-5 is strongly correlated with the RS-11 (r = .89) and, like the RS-11, conceived of as a one-dimensional construct, although it does contain items from both facets of psychological resilience as measured by the original RS-25 (Personal competence, e.g., "I am determined"; Acceptance of self and life, e.g. "I can usually find

something to laugh about"). While there is currently no estimate of temporal stability of the RS-5, fairly high stabilities have been found for the RS-25 (r = .67 - .84 for intervals from 1 to 12 months, Wagnild and Young, 1993) and various adoptions of it (r = .78 after one month, Lundman et al., 2007; r = .90 after three months, Portzky et al., 2010; r = .90 after six months, Ruiz-Párraga et al., 2012).

In the present sample, the RS-5 scores were left-skewed (Skewness = -1.12), indicating a larger proportion of high scores. The score range was 7.5 to 35 with a sample median of 30, and 95 % of participants had scores between 20 and 35. This is in agreement with earlier studies, where mean resilience scale scores near the high end of the scale have often been found in older adults (van Kessel, 2013).

Outcome variable

Depressive symptoms score and depressed mood. A German translation (Arbeitsgruppe Geriatrisches Assessment, 1997) of the 15-item version of the Geriatric Depression Scale (GDS-15; Sheikh and Yesavage, 1986) was administered as part of the telephone interview. The GDS-15 is applicable in elderly populations without severe cognitive impairment (Wancata et al., 2006). It consists of 15 yes/no questions, none of which relate to bodily pain. Items are summed to a score between 0 and 15. Up to four missing item values were replaced by the mean score of the remaining items; otherwise, the participant was assigned a missing value. GDS-15 scores were right-skewed (Skewness = 1.67) and concentrated near the low end of the scale, with 15.9% having a score of 5 or more, and 2.4% scoring 10 or more. For logistic regression analyses, participants with a score ≥ 5 were classified as having "depressed mood". This cut-off value has been used for depression screening in older adults in a variety of settings (primary care, rehabilitation, inpatients), with sensitivity to detect depression (as diagnosed by clinical interview) ranging between 60 and 95%, and specificity between 60 and 85% (Wancata et al., 2006).

Confounding variables

Both chronic pain and depressive symptoms may be influenced by social support (Bergman et al., 2002; Grav et al., 2012), socioeconomic status (Bergman et al., 2001; Everson et al., 2002), body weight (Luppino et al., 2010; Mundal et al., 2014), physical illness (Turvey et al., 2009; Dominick et al., 2012), stress (Blackburn-Munro, 2004; Häuser et al., 2012), physical activity (Busch et al., 2007;

Mammen and Faulkner, 2013), sleep quality (Smith and Haythornthwaite, 2004; Lee et al., 2013; Vitiello et al., 2014), cognitive status (Lee et al., 2010; Curran and Loi, 2013), alcohol use (Bergman et al., 2002; Gea et al., 2013), and pain medication intake, therefore measures of these variables were included besides sex and age as confounders in regression models.

As a proxy for social support, a binary variable indicating whether participants were currently living together with a partner or alone was defined. Socioeconomic status was based on vocational education (None: no vocational degree; Basic: basic crafts and trades; Advanced: higher crafts and trades, Engineering school, College, University). Body mass index (kg / m^2) was determined based on height and weight measurements taken during the examination. The number of participant-reported illnesses (lung, kidney, liver, joint, gastrointestinal, eye, cardiovascular, and neurological conditions, hypertension, stroke, diabetes, and cancer) was used to assess burden of physical comorbidity. The list of illnesses was based on a modification (Kirchberger et al., 2012) of the self-report generated Charlson Comorbidity Index (Chaudhry et al., 2005), but did not include mental disorders. Stress was based on a binary variable indicating whether or not participants had experienced a stressful life event (such as illness, death or severe disease of a relative, family conflict, or financial trouble) during the previous year. Binary variables based on self-report were also used to code for physical activity (Engaged in physical activity for at least one hour per week on average?), sleeping problems (Frequent difficulties with either falling or staying asleep?), regular alcohol use (Alcohol usually consumed more than once per week?), and pain medication intake (Currently any use of opioids or regular use of NSAIDs?). Finally, cognitive functioning was assessed using a German translation of the Modified Telephone Interview for Cognitive Status (TICS-M), adjusted for education (Perneczky, 2003). The TICS-m score ranges from 0 to 50, where higher scores indicate better cognitive status. Values between 28 and 31 are indicative of mild cognitive impairment, and values ≤ 27 are indicative of dementia (Knopman et al., 2010).

Statistical analyses

Descriptive statistics for all variables were calculated for the overall sample and stratified by pain status. Unadjusted comparisons between pain status groups were made for all model variables using Pearson's chi square test for categorical and the Kruskal-Wallis test for quantitative variables.

Subsequently, two types of covariate-adjusted regression analyses were used to model the outcome depressive symptoms: (a) binary logistic regression to predict the likelihood of depressed mood (GDS-15 ≥ 5 vs. < 5), and (b) quantile regression to predict the .25, .50, and .75 quantile of the GDS-15 score distribution.

Quantile regression does not make any distributional assumptions about the outcome and is thus well-suited for the analysis of the right-skewed depression scale scores. The .50 quantile regression models the effects of the covariates on the median of the outcome distribution (similar to conventional regression techniques modeling the mean), while the .25 and .75 quantile regressions model the lower and upper quartile of the outcome distribution, respectively, allowing for an analysis of the effects of covariates on extreme rather than average values (Koenker and Hallock, 2001; Beyerlein, 2014). We chose these quantiles a priori as indicators for participants with low, medium, and high levels of depressive symptoms. The rationale behind this approach was that the protective effect of resilience may also be visible in shifts of the lower and upper parts of the depression score distribution, rather than only in shifts of the overall average. Quantile regression parameters were estimated by the internal point algorithm and confidence intervals by bootstrapping.

Logistic and quantile regression models initially contained only pain status, sex, and age as independent variables. Further confounding covariates were added in a consecutive manner. In the last step, the resilience score and its interaction with pain status were included in the fully confounder-adjusted model. In order to further investigate the nature of the pain-resilience interaction in different age groups, the logistic and quantile interaction models were additionally run separately for each of three age groups (less than 75 years, 75 – 84 years, and 85 years and older). Also, as the distribution of resilience scores in the sample was markedly left-skewed, the interaction models were re-run excluding these potentially influential low resilience cases as a sensitivity analysis.

All logistic regression coefficients are presented in exponentiated form, such that main effects can be interpreted as odds ratios, and interaction effects as multipliers of the corresponding main effects. Coefficients of quantile regressions are untransformed, such that main effects can be interpreted as differences in GDS-15 score quantiles, and interaction effects as differences of the

corresponding main effects. All statistical analyses were performed using the SAS 9.2 and 9.3 for Windows software (SAS Institute Inc., Cary, NC, USA). All reported P values are two-tailed.

Results

Participant characteristics

Participants included in the analyses are described in Table 1, both overall and stratified by pain status. Of these 724 participants, 219 (30.3%) experienced no chronic pain, 416 (57.5%) had CLP, and 89 (12.3%) suffered from CWP. In men, CLP and CWP prevalences were 53.2% and 9.2%, respectively. Among women, 61.6% had CLP and 15.3% had CWP.

Depressive symptoms as measured by GDS-15 increased strongly and significantly with pain extent, as did the proportion of participants with depressed mood (from 7.3% in the pain-free to 15.1% in those with local pain, and to 40.5% in those with widespread pain). Similarly strong increases across pain status strata were apparent for the proportion of females, number of physical comorbidities, sleeping problems, and pain medication intake. There were also clearly detectable group differences in age, BMI, and likelihood of a recent stressful even (increasing with pain extent), as well as vocational education, physical activity, and alcohol use (decreasing with pain extent). Likelihood of living with a partner and resilience score tended to be lower in those with greater pain extent. No appreciable differences between the pain status groups were found in cognitive functioning.

In the present sample, the GDS-15 score and RS-5 score were moderately negatively correlated (r = -0.35, 95% CI -0.41 to -0.29). Depressive symptoms increased markedly with increasing age, particularly in women and in the oldest participants (aged 85+). Whereas resilience scores did not differ across age groups in men, they decreased significantly with age in women (Supplementary Table S2).

Association of chronic local pain with depressive symptoms

In the sex- and age-adjusted logistic regression model, participants with CLP were nearly twice as likely to have depressed mood as pain-free participants (OR 1.85, 95% CI 1.02 – 3.35; see Table 2). After additionally adjusting for confounding factors, the estimated odds of having depressed mood were still increased in participants with CLP but this association did not reach statistical

significance any more. In particular, the inclusion of burden of physical comorbidities in the model attenuated the effect of CLP and reduced its effect to non-significance (Supplementary Table S3).

Correspondingly, in sex- and age-adjusted quantile regression models, GDS-15 quartiles were significantly increased in participants with CLP, compared to pain-free participants. The effects in participants with high depression scores and in those with average depression scores was somewhat larger than the effect in participants with low depression scores (difference of upper quartiles: β = 0.54, 95% CI -0.01 – 1.09; medians: β = 0.51, 95% CI 0.10 – 0.91; lower quartiles: β = 0.36, 95% CI 0.13 – 0.59). However, after full adjustment for confounders, the effects were all reduced to non-significance. Again, the coefficients were most markedly reduced by the introduction of physical comorbidities into the model (Supplementary Table S4).

Association of chronic widespread pain with depressive symptoms

The likelihood of depressed mood in CWP (compared to no pain) was strongly increased in the sex- and age-adjusted logistic regression model (OR 6.91, 95% CI 3.45 – 13.82). Even after adjusting for all confounding covariates, participants with CWP were still four times as likely to have depressed mood compared to those without pain (OR 4.08, 95% CI 1.90 – 8.74).

In the sex- and age-adjusted quantile regression models, there was a clear and significant increase in the GDS-15 scores of participants with CWP compared to no pain participants, which was most pronounced in participants with high levels of depressive symptoms (difference of upper GDS-15 quartiles: β = 3.31, 95% CI 2.33 – 4.28), intermediate in those with average symptom levels (difference of medians: β = 2.51, 95% CI 1.62 – 3.39), and least in those with low symptom levels (difference of lower quartiles: β = 1.29, 95% CI 0.68 – 1.89). As with logistic regression, adjusting the quantile regression models for confounders decreased the effect size for CWP, but changed neither the significance nor the pattern of results (difference of upper GDS-15 quartiles: β = 2.07, 95% CI 1.08 – 3.07; medians: β = 1.14, 95% CI 0.20 – 2.08; lower quartiles: β = 0.92, 95% CI 0.35 – 1.49).

As was the case for CLP, the effect of CWP was most strongly reduced by the introduction of number of comorbidities both in logistic and quantile regression models, highlighting the role of physical illness in pain and depression among the elderly. Overall, the effects of confounding covariates were consistent with theoretical expectations (Tables S3 and S4).

Effect modification by resilience

The moderating effects of resilience on the observed association between pain and depressive symptoms are shown in Tables 3 and 4. In quantile regressions, resilience significantly modified the effect of CWP in those participants with low or average depression scores (regression of lower quartile: β = -0.18, 95% CI -0.32 to -0.04; median: β = -0.17, 95% CI -0.30 to -0.04). Consistent with the hypothesis, the interaction coefficients were negative, indicating an attenuation of the association of CWP with depressive symptoms in more compared to less resilient individuals. However, in participants with high depression scores, the effect of CWP did not differ significantly between more or less resilient individuals (β = -0.07, 95% CI -0.31 to 0.17).

Fig. 2 illustrates the protective effect of resilience. In individuals with the highest possible resilience score (35), the effect of CWP on the GDS-15 was estimated to be near zero for the lower quartile, and approximately 0.5 for the median, as opposed to differences of about 2.5 (lower quartile) and 3 points (median) in those individuals with a RS-5 score of 20 (the 5th percentile of the sample RS-5 distribution).

The resilience scores of the sample were concentrated at the upper end of the RS-5 scale, with only 5% of participants having scores of 20 or lower. For these low resilience individuals, the estimated effect of CWP appeared disproportionately high. Therefore, in a sensitivity analysis, we re-ran the quantile regression models excluding these potentially influential observations, leaving 693 participants with a RS-5 score of 20 or higher. While the interaction effect on the GDS-15 lower quartile remained significant (β = -0.18, 95% CI -0.30 to -0.06), the effect on the median was attenuated in magnitude and did not reach significance any more (β = -0.08, 95% CI -0.20 to 0.05).

Inspection of the quantile regression coefficients within age subgroups suggested that the overall interaction effect was primarily driven by the participants aged 75 to 84 years (Supplementary Table S5). In this subgroup, the interaction between CWP and RS-5 score was close to the overall effect in size and direction for the lower GDS-15 quartile and median, and the corresponding p-values were around the 5% mark. Other coefficients involving CWP had wide confidence intervals, making interpretation difficult (all p > 0.39). Notably, interactions involving CLP tended to be in the positive

direction in participants aged less than 75 or more than 84 years, suggesting a more adverse effect of CLP in high-resilience participants. However, none of these effects reached statistical significance.

In contrast to quantile regressions of the quantitative GDS-15 score, the effect of CWP (vs. no pain) on the dichotomized variable depressed mood was clearly not modified by resilience score in the logistic regression model ($P = 0.442$; Table 4). There was no indication that resilience modified the effect of CLP (vs. no pain) on depressive symptoms. Coefficients for the interaction of CLP with resilience score were low and did not approach significance in both logistic and quantile regressions. Age-stratified analyses also gave no indication of effect modification of either CLP or CWP in any of the three age subgroups (Table S5).

In both quantile and logistic regression models, resilience score was significantly negatively associated with symptoms of depression, indicating a general protective effect of psychological resilience regardless of pain status (note that the effect of resilience score as reported in Tables 3 and 4 is the simple main effect in pain-free participants). However, due to the effect modification, this protective effect appears to be particularly strong in participants affected by CWP.

Discussion

In this study, we investigated how resilience moderates the association between chronic pain and depressive symptoms in older adults. While CWP was strongly associated with depressive symptoms, this association was reduced in resilient participants, particularly in those aged 75 to 84. CLP was not associated with significant increases in depressive symptoms after adjustment for confounding factors, and no moderating effect of resilience was present.

Prevalence of pain and depressive symptoms

CLP and CWP prevalences were 57.5 and 12.3%, respectively. Both conditions were more frequent in women than in men. The results are consistent with earlier prevalence estimates in old adults, which range between 25 to 65% for CLP, 5 to 15% for CWP in men, and 15 to 20 % for CWP in women (Croft et al., 1993; Bergman et al., 2001; Leveille et al., 2005; Gibson, 2007; Häuser et al., 2012), and underscore the magnitude of the problem of chronic pain in old adults.

About 16% of participants indicated elevated levels of depressive symptoms, which is near the upper end of the prevalence range for clinically significant depressive symptoms found in previous studies of community-dwelling old adults (8-16%, Blazer, 2003). Symptoms were higher among the oldest of our study participants. This may be related to the increased burden of comorbidity and frailty in the oldest old (Blazer, 2003). Accordingly, burden of physical comorbidities was identified as an important contributing factor to elevated depressive symptoms in our analyses.

Effects of chronic local pain

Participants with CLP were about twice as likely to suffer from depressed mood, compared to pain-free participants. However, after confounder adjustment, no significant differences to pain-free participants were found, which contrasts with findings of increased incidence of depression and anxiety in chronic pain patients (Gerrits et al., 2014). Possibly, the effect of CLP was not detectable due to overadjustment. On the other hand, old adults may cope fairly well with localized pain, considering that many old adults consider themselves successful agers despite chronic illness (Strawbridge et al., 2002). Given the cross-sectional nature of the study, it is possible that participants suffering from CLP had already successfully adapted to their condition.

Effects of chronic widespread pain

Participants with CWP were at a high risk of having poor mental health. After confounder adjustment, CWP was associated with a fourfold increase in the odds of suffering from a depressed mood. However, our analysis indicated that a resilient personality can exert a protective effect. In participants with the highest possible resilience score, the GDS-15 lower quartiles and medians of the CWP group and the pain-free group were almost equal, according to quantile regression models. Among highly resilient individuals, many who are afflicted by CWP appear to maintain or regain a level of mental health which is close to that of their pain-free peers.

Notably, the protective effect of resilience was not clearly visible in the model of the upper quartile. Thus, even within highly resilient old adults, there is a subgroup with elevated depressive symptoms in CWP, compared to those without pain. Possibly, if depressive symptoms are already present when CWP develops, this double burden may be too severe even for a resilient person, leading to an exacerbation of the depressive condition.

Psychological resilience as a protective factor in old age

In our study, we focused on individual psychological resilience and assumed certain degree of temporal stability, since several earlier studies had found rather high retest correlations (e.g., Lundman et al., 2007). Yet, there is an increasing interest in interventions designed to increase individual resilience. Such programs may have small to moderate positive effects (Leppin et al., 2014). Psychosocial interventions are used to specifically help older adults cope with chronic pain (Keefe et al., 2013). The finding that a resilient personality is protective, specifically in CWP, suggests that such interventions may potentially be beneficial in older adults suffering from CWP. Consistent with this, in a recent experimental study, a participant's state of mindfulness was effective in reducing pain-related affect, but only in individuals with a tendency to catastrophize pain (Prins et al., 2014).

Chronic pain has the capacity to disrupt the patient's sense of identity (Morley, 2008). However, older adults often draw considerable strength from a continuous narrative of their life history and accomplishments (Hildon et al., 2008). Life review therapy (Bohlmeijer et al., 2003) may be an effective way of strengthening the sense of continuity in older adults with CWP. As the age-stratified analyses of the present study suggested, however, there may be heterogeneity within the group of old adults, which might need to be taken into account in the design of therapeutic interventions. The protective effect of resilience was primarily visible in "older old" participants (75 – 84 years), but not in the "younger old" or "oldest old". However, these findings should be considered with caution due to lack of statistical power and require further investigation.

Finally, resilience is a multifaceted construct operating interactively on different system levels (Wild et al., 2013). Somebody living in a long-familiar neighborhood with well-functioning infrastructure is more likely to have frequent positive social encounters and activities, which may in turn foster psychological resilience factors such as optimism and personal capabilities (Hildon et al., 2008). Chronic pain conditions are frequently attributed to "problematic" individual behavior and coping styles, resulting in alienation between patients and health professionals (Eccleston et al., 1997), which highlights the danger of focusing exclusively on the more "proximal" facets of resilience. The interplay of community, social, and individual aspects of resilience in old adults with chronic pain is thus an important avenue for future research.

Strengths and limitations

This study has a number of strengths. The data are recent and drawn from a well-established research platform with standardized procedures and quality control (Holle et al., 2005). Due to stratified sampling, very old individuals are well represented. Validated instruments were used in the assessment of the outcome and moderator variable. Information on a large number of potential confounders is available and controlled for, and the employed statistical method allows for a more nuanced analysis of the relation between pain, depressive symtpoms, and resilience than do conventional regression models (Beyerlein, 2014). Finally, the analyzed outcome is of strong clinical relevance, especially given the strong association of depression with suicidality in the elderly (Fiske et al., 2009).

However, due to the cross-sectional design of the present study, causality cannot be established. Bidirectional effects are in general pervasive in the relation between pain and depression, since the two conditions not only reciprocally influence each other (Kroenke et al., 2011), but are also likely to both impact and be impacted by third factors such as sleep quality and physical activity (Smith and Haythornthwaite, 2004; Lopresti et al., 2013). Controlling for these factors may in fact lead to overadjustment and therefore underestimate the net effect of chronic pain on symptoms of depression; we nevertheless chose to include such variables in our analysis to avoid spurious results. It was also not possible to assess the assumed temporal stability of psychological resilience. However, the results of earlier studies suggest at least short- to medium-term stability, as discussed above.

While many studies apply a definition of chronic pain as pain that lasts more than three months (IASP, 1986), the current study asked for pain that occurred "on a regular basis once or several times per week". It is possible that some participants with acute pain were falsely treated as having chronic pain, although the wording of the question may be sufficiently strict in order to exclude most cases of acute pain. Selection bias may have arisen from non-participation (Hunger et al., 2013) or from incomplete data in the more frail participants, as indicated by our non-responder analysis. Finally, a sensitivity analysis indicated that the observed interaction effect on the median GDS-15 score may at least partly be due to a few influential observations with very low resilience scores.

Nonetheless, the direction of the effect remained unchanged, and the interaction effect on the lower GDS-15 quartile was unaffected.

Conclusion

In summary, this study indicates that even though old adults with CWP are at high risk of depressed mood, this adverse effect can be buffered by psychological resilience. On the other hand, there was no clear evidence for substantial increases in depressive symptoms or a buffering effect of resilience in individuals with CLP. This suggests that old adults with CWP may potentially benefit from interventions, both on the individual as well as the community level.

Prospective studies may help to disentangle complex cause-effect relationships. A clinically highly relevant research question would be to investigate whether a resilient personality may, in the long term, help to prevent a vicious circle of distress and central sensitization (Larsson et al., 2012). The effects of social, community, and environmental factors on individual resilience in chronic pain also require further study. Such studies may help determine which effects different interventions might have when applied at different times during an individual's life span, as well as the role of resilience during different stages of "old" age.

Acknowledgements

The authors would like to thank Margit Heier and Saskia Weber for technical assistance, and Alexander von Eisenhart Rothe for discussion and comments.

Author contributions

All authors discussed the results and commented on the manuscript. HB, RTE, and KHL made substantial contributions to the conception and design. HB, RTE, and KHL made substantial contributions to the data acquisition. HB and JB made significant contributions to the analysis and interpretation of data. HB, RTE, JB, and KHL drafted and revised the manuscript.

References

Arbeitsgruppe Geriatrisches Assessment (1997). *Geriatrisches Basisassessment. Handlungsanleitungen für die Praxis* (Munich: MMV).

Bergman, S., Herrström, P., Högström, K., Petersson, I.F., Svensson, B., Jacobsson, L.T. (2001). Chronic musculoskeletal pain, prevalence rates, and sociodemographic associations in a Swedish population study. *J Rheumatol* **28**,1369–1377.

Bergman, S., Herrström, P., Jacobsson, L.T., Petersson, I.F. (2002). Chronic widespread pain: a three year followup of pain distribution and risk factors. *J Rheumatol* **29**,818–825.

Beyerlein, A. (2014). Quantile regression - opportunities and challenges from a user's perspective. *Am J Epidemiol* **180**,330–331.

Blackburn-Munro, G. (2004). Hypothalamo-pituitary-adrenal axis dysfunction as a contributory factor to chronic pain and depression. *Curr Pain Headache Rep* **8**,116–124.

Blazer, D.G. (2003). Depression in late life: review and commentary. *J Gerontol A Biol Sci Med Sci* **58**, 249–265.

Bohlmeijer, E., Smit, F., Cuijpers, P. (2003). Effects of reminiscence and life review on late-life depression: a meta-analysis. *Int J Geriatr Psychiatry* **18**, 1088–1094.

Busch, A.J., Barber, K.A., Overend, T.J., Peloso, P.M., Schachter, C.L. (2007). Exercise for treating fibromyalgia syndrome. *Cochrane Database Syst Rev* **2007**,CD003786.

Chaudhry, S., Jin, L., Meltzer, D. (2005). Use of a self-report-generated Charlson Comorbidity Index for predicting mortality. *Med Care* **43**,607–615.

Croft, P., Rigby, A.S., Boswell, R., Schollum, J., Silman, A. (1993). The prevalence of chronic widespread pain in the general population. *J Rheumatol* **20**,710–713.

Curran, E.M., Loi, S. (2013). Depression and dementia. *Med J Aust* **199(6 Suppl.)**,S40-S44.

Denkinger, M.D., Lukas, A., Nikolaus, T., Peter, R., Franke, S. (2014). Multisite pain, pain frequency and pain severity are associated with depression in older adults: results from the ActiFE Ulm study. *Age Ageing* **43**,510–514.

Dominick, C.H., Blyth, F.M., Nicholas, M.K. (2012). Unpacking the burden: understanding the relationships between chronic pain and comorbidity in the general population. *Pain* **153**, 293–304.

Duggleby, W., Hicks, D., Nekolaichuk, C., Holtslander, L., Williams, A., Chambers, T., Eby, J. (2012). Hope, older adults, and chronic illness: a metasynthesis of qualitative research. *J Adv Nurs* **68**, 1211–1223.

Eccleston, C., Williams, A.C., Rogers, W.S. (1997). Patients' and professionals' understandings of the causes of chronic pain: blame, responsibility and identity protection. *Soc Sci Med* **45**, 699–709.

Everson, S.A., Maty, S.C., Lynch, J.W., Kaplan, G.A. (2002). Epidemiologic evidence for the relation between socioeconomic status and depression, obesity, and diabetes. *J Psychosom Res* **53**,891–895.

Fiske, A., Wetherell, J.L., Gatz, M. (2009). Depression in older adults. *Annu Rev Clin Psychol* **5**,363–389.

Gea, A., Beunza, J.J., Estruch, R., Sánchez-Villegas, A., Salas-Salvadó, J., Buil-Cosiales, P., Gómez-Gracia, E., Covas, M.-I., Corella, D., Fiol, M., Arós, F., Lapetra, J., Lamuela-Raventós, R.-M., Wärnberg, J., Pintó, X., Serra-Majem, L., Martínez-González, M.A. (2013). Alcohol intake, wine consumption and the development of depression: the PREDIMED study. *BMC Med* **11**,192.

Gerrits, M.M., van Oppen, P., van Marwijk, H.W., Penninx, B.W., van der Horst, H.E. (2014). Pain and the onset of depressive and anxiety disorders. *Pain* **155**,53–59.

Gibson, S.J. (2007). IASP global year against pain in older persons: highlighting the current status and future perspectives in geriatric pain. *Expert Rev Neurother* **7**,627–635.

Grav, S., Hellzèn, O., Romild, U., Stordal, E. (2012). Association between social support and depression in the general population: the HUNT study, a cross-sectional survey. *J Clin Nurs* **21**,111–120.

Hanfstingl, B. (2013). Ego and spiritual transcendence: relevance to psychological resilience and the role of age. *Evid Based Complement Alternat Med* **2013**, 949838.

Häuser, W., Glaesmer, H., Schmutzer, G., Brähler, E. (2012). Widespread pain in older Germans is associated with posttraumatic stress disorder and lifetime employment status--results of a cross-sectional survey with a representative population sample. *Pain* **153**,2466–2472.

Hildon, Z., Smith, G., Netuveli, G., Blane, D. (2008). Understanding adversity and resilience at older ages. *Sociol Health Illn* **30**, 726–740.

Holle, R., Happich, M., Löwel, H., Wichmann, H.E. (2005). KORA--a research platform for population based health research. *Gesundheitswesen* **67(Suppl. 1)**,S19-S25.

Hunger, M., Schwarzkopf, L., Heier, M., Peters, A., Holle, R. (2013). Official statistics and claims data records indicate non-response and recall bias within survey-based estimates of health care utilization in the older population. *BMC Health Serv Res* **13**,1.

IASP (1986). Classification of chronic pain. Descriptions of chronic pain syndromes and definitions of pain terms. Prepared by the International Association for the Study of Pain, Subcommittee on Taxonomy. *Pain Suppl **3***,S1-S226.

Keefe, F.J., Porter, L., Somers, T., Shelby, R., Wren, A.V. (2013). Psychosocial interventions for managing pain in older adults: outcomes and clinical implications. *Br J Anaesth* **111**,89–94.

Kirchberger, I., Meisinger, C., Heier, M., Zimmermann, A.-K., Thorand, B., Autenrieth, C.S., Peters, A., Ladwig, K.-H., Döring, A. (2012). Patterns of multimorbidity in the aged population. Results from the KORA-Age study. *PLoS ONE* **7**,e30556.

Knopman, D.S., Roberts, R.O., Geda, Y.E., Pankratz, V.S., Christianson, T.J., Petersen, R.C., Rocca, W.A. (2010). Validation of the telephone interview for cognitive status-modified in subjects with normal cognition, mild cognitive impairment, or dementia. *Neuroepidemiology* **34**,34–42.

Koenker, R., Hallock, K.F. (2001). Quantile Regression. *J Econ Perspect* **15**,143–156.

Kroenke, K., Wu, J., Bair, M.J., Krebs, E.E., Damush, T.M., Tu, W. (2011). Reciprocal relationship between pain and depression: a 12-month longitudinal analysis in primary care. *J Pain* **12**,964–973.

Landrø, N.I., Fors, E.A., Våpenstad, L.L., Holthe, Ø., Stiles, T.C., Borchgrevink, P.C. (2013). The extent of neurocognitive dysfunction in a multidisciplinary pain centre population. Is there a relation between reported and tested neuropsychological functioning? *Pain* **154**, 972–977.

Larsson, B., Björk, J., Börsbo, B., Gerdle, B. (2012). A systematic review of risk factors associated with transitioning from regional musculoskeletal pain to chronic widespread pain. *Eur J Pain* **16**,1084–1093.

Lee, D.M., Pendleton, N., Tajar, A., O'Neill, T.W., O'Connor, D.B., Bartfai, G., Boonen, S., Casanueva, F.F., Finn, J.D., Forti, G., Giwercman, A., Han, T.S., Huhtaniemi, I.T., Kula, K., Lean, M.E., Punab, M., Silman, A.J., Vanderschueren, D., Moseley, C.M., Wu, F.C., McBeth, J. (2010). Chronic widespread pain is associated with slower cognitive processing speed in middle-aged and older European men. *Pain* **151**,30–36.

Lee, E., Cho, H.J., Olmstead, R., Levin, M.J., Oxman, M.N., Irwin, M.R. (2013). Persistent sleep disturbance: a risk factor for recurrent depression in community-dwelling older adults. *Sleep* **36**,1685–1691.

Leppin, A.L., Bora, P.R., Tilburt, J.C., Gionfriddo, M.R., Zeballos-Palacios, C., Dulohery, M.M., Sood, A., Erwin, P.J., Brito, J.P., Boehmer, K.R., Montori, V.M. (2014). The efficacy of resiliency training programs: a systematic review and meta-analysis of randomized trials. *PLoS ONE* **9**, e111420.

Leveille, S.G., Ling, S., Hochberg, M.C., Resnick, H.E., Bandeen-Roche, K.J., Won, A., Guralnik, J.M. (2001). Widespread musculoskeletal pain and the progression of disability in older disabled women. *Ann Intern Med* **135**,1038–1046.

Leveille, S.G., Zhang, Y., McMullen, W., Kelly-Hayes, M., Felson, D.T. (2005). Sex differences in musculoskeletal pain in older adults. *Pain* **116**,332–338.

Lopresti, A.L., Hood, S.D., Drummond, P.D. (2013). A review of lifestyle factors that contribute to important pathways associated with major depression: diet, sleep and exercise. *J Affect Disord* **148**,12–27.

Lundman, B., Strandberg, G., Eisemann, M., Gustafson, Y., Brulin, C. (2007). Psychometric properties of the Swedish version of the Resilience Scale. *Scand J Caring Sci* **21**, 229–237.

Luppino, F.S., de Wit, L.M., Bouvy, P.F., Stijnen, T., Cuijpers, P., Penninx, B.W., Zitman, F.G. (2010). Overweight, obesity, and depression: a systematic review and meta-analysis of longitudinal studies. *Arch Gen Psychiatry* **67**,220–229.

Mammen, G., Faulkner, G. (2013). Physical activity and the prevention of depression: a systematic review of prospective studies. *Am J Prev Med* **45**,649–657.

Morley, S. (2008). Psychology of pain. *Br J Anaesth* **101**, 25–31.

Mundal, I., Gråwe, R.W., Bjørngaard, J.H., Linaker, O.M., Fors, E.A. (2014). Psychosocial factors and risk of chronic widespread pain: an 11-year follow-up study--the HUNT study. *Pain* **155**,1555–1561.

Nagel, B., Gerbershagen, H.U., Lindena, G., Pfingsten, M. (2002). Entwicklung und empirische Überprüfung des Deutschen Schmerzfragebogens der DGSS. *Schmerz* **16**,263–270.

Nordeman, L., Gunnarsson, R., Mannerkorpi, K. (2012). Prevalence and characteristics of widespread pain in female primary health care patients with chronic low back pain. *Clin J Pain* **28**,65–72.

Perneczky, R. (2003). Die Eignung einfacher klinischer Tests für die Erkennung der leichten kognitiven Störung und der leichtgradigen Demenz. *Akt Neurol* **30**,114–117.

Peters, A., Döring, A., Ladwig, K.-H., Meisinger, C., Linkohr, B., Autenrieth, C., Baumeister, S.E., Behr, J., Bergner, A., Bickel, H., Bidlingmaier, M., Dias, A., Emeny, R.T., Fischer, B., Grill, E., Gorzelniak, L., Hänsch, H., Heidbreder, S., Heier, M., Horsch, A., Huber, D., Huber, R.M.,

Jörres, R.A., Kääb, S., Karrasch, S., Kirchberger, I., Klug, G., Kranz, B., Kuch, B., Lacruz, M.E., Lang, O., Mielck, A., Nowak, D., Perz, S., Schneider, A., Schulz, H., Müller, M., Seidl, H., Strobl, R., Thorand, B., Wende, R., Weidenhammer, W., Zimmermann, A.-K., Wichmann, H.-E., Holle, R. (2011). Multimorbidität und erfolgreiches Altern: Ein Blick auf die Bevölkerung im Rahmen der KORA-Age-Studie. *Z Gerontol Geriat* **44(Suppl. 2)**,41–54.

Portzky, M., Wagnild, G., de Bacquer, D., Audenaert, K. (2010). Psychometric evaluation of the Dutch Resilience Scale RS-nl on 3265 healthy participants: a confirmation of the association between age and resilience found with the Swedish version. *Scand J Caring Sci* **24 Suppl 1**, 86–92.

Prins, B., Decuypere, A., van Damme, S. (2014). Effects of mindfulness and distraction on pain depend upon individual differences in pain catastrophizing: an experimental study. *Eur J Pain* **18**,1307–1315.

Ramírez-Maestre, C., Esteve, R. (2014). The role of sex/gender in the experience of pain: resilience, fear, and acceptance as central variables in the adjustment of men and women with chronic pain. *J Pain* **15**,608-618.e1.

Ruiz-Párraga, G.T., López-Martínez, A.E., Esteve, R., Ramírez-Maestre, C., Wagnild, G. (2015). A confirmatory factor analysis of the Resilience Scale adapted to chronic pain (RS-18): new empirical evidence of the protective role of resilience on pain adjustment. *Qual Life Res* **24**, 1245–1253.

Ruiz-Párraga, G.T., López-Martínez, A.E., Gómez-Pérez, L. (2012). Factor structure and psychometric properties of the resilience scale in a spanish chronic musculoskeletal pain sample. *J Pain* **13**, 1090–1098.

Schumacher, J. (2005). Die Resilienzskala - Ein Fragebogen zur Erfassung der psychischen Widerstandsfähigkeit als Personmerkmal. *Z Klin Psychol Psychiatr Psychother* **53**,16–39.

Sheikh, J.I., Yesavage, J.A. (1986). Geriatric Depression Scale (GDS). *Clin Gerontologist* **5**,165–173.

Smith, M.T., Haythornthwaite, J.A. (2004). How do sleep disturbance and chronic pain inter-relate? Insights from the longitudinal and cognitive-behavioral clinical trials literature. *Sleep Med Rev* **8**,119–132.

Strawbridge, W.J., Wallhagen, M.I., Cohen, R.D. (2002). Successful aging and well-being: self-rated compared with Rowe and Kahn. *Gerontologist* **42**,727–733.

Sturgeon, J.A., Zautra, A.J. (2010). Resilience: a new paradigm for adaptation to chronic pain. *Curr Pain Headache Rep* **14**,105–112.

Tang, N.K., Crane, C. (2006). Suicidality in chronic pain: a review of the prevalence, risk factors and psychological links. *Psychol Med* **36**,575–586.

Turvey, C.L., Schultz, S.K., Beglinger, L., Klein, D.M. (2009). A longitudinal community-based study of chronic illness, cognitive and physical function, and depression. *Am J Geriatr Psychiatry* **17**,632–641.

van Kessel, G. (2013). The ability of older people to overcome adversity: a review of the resilience concept. *Geriatr Nurs* **34**, 122–127.

Viniol, A., Jegan, N., Leonhardt, C., Brugger, M., Strauch, K., Barth, J., Baum, E., Becker, A. (2013). Differences between patients with chronic widespread pain and local chronic low back pain in primary care--a comparative cross-sectional analysis. *BMC Musculoskelet Disord* **14**,351.

Vitiello, M.V., McCurry, S.M., Shortreed, S.M., Baker, L.D., Rybarczyk, B.D., Keefe, F.J., von Korff, M. (2014). Short-term improvement in insomnia symptoms predicts long-term improvements in sleep, pain, and fatigue in older adults with comorbid osteoarthritis and insomnia. *Pain* **155**,1547–1554.

von Eisenhart Rothe, A., Zenger, M., Lacruz, M., Emeny, R., Baumert, J., Haefner, S., Ladwig, K.-H., Lacruz, M.E. (2013). Validation and development of a shorter version of the resilience scale RS-11: results from the population-based KORA–age study. *BMC Psychol* **1**,25.

Wagnild, G.M., Young, H.M. (1993). Development and psychometric evaluation of the Resilience Scale. *J Nurs Meas* **1**,165–178.

Wancata, J., Alexandrowicz, R., Marquart, B., Weiss, M., Friedrich, F. (2006). The criterion validity of the Geriatric Depression Scale: a systematic review. *Acta Psychiatr Scand* **114**,398–410.

Waugh, C.E., Thompson, R.J., Gotlib, I.H. (2011). Flexible emotional responsiveness in trait resilience. *Emotion* **11**,1059–1067.

Wild, K., Wiles, J.L., Allen, R. E. S. (2013). Resilience: thoughts on the value of the concept for critical gerontology. *Ageing Soc* **33**, 137–158.

Wiles, J.L., Wild, K., Kerse, N., Allen, R. E. S. (2012). Resilience from the point of view of older people: 'There's still life beyond a funny knee'. *Soc Sci Med* **74**, 416–424.

Wilkie, R., Tajar, A., McBeth, J. (2013). The onset of widespread musculoskeletal pain is associated with a decrease in healthy ageing in older people: a population-based prospective study. *PLoS ONE* **8**,e59858.

Wolfe, F., Smythe, H.A., Yunus, M.B., Bennett, R.M., Bombardier, C., Goldenberg, D.L., Tugwell, P., Campbell, S.M., Abeles, M., Clark, P. (1990). The American College of Rheumatology 1990 Criteria for the Classification of Fibromyalgia. Report of the Multicenter Criteria Committee. *Arthritis Rheum* **33**,160–172.

Zhu, Z., Galatzer-Levy, I.R., Bonanno, G.A. (2014). Heterogeneous depression responses to chronic pain onset among middle-aged adults: a prospective study. *Psychiatry Res* **217**,60–66.

Figures and tables

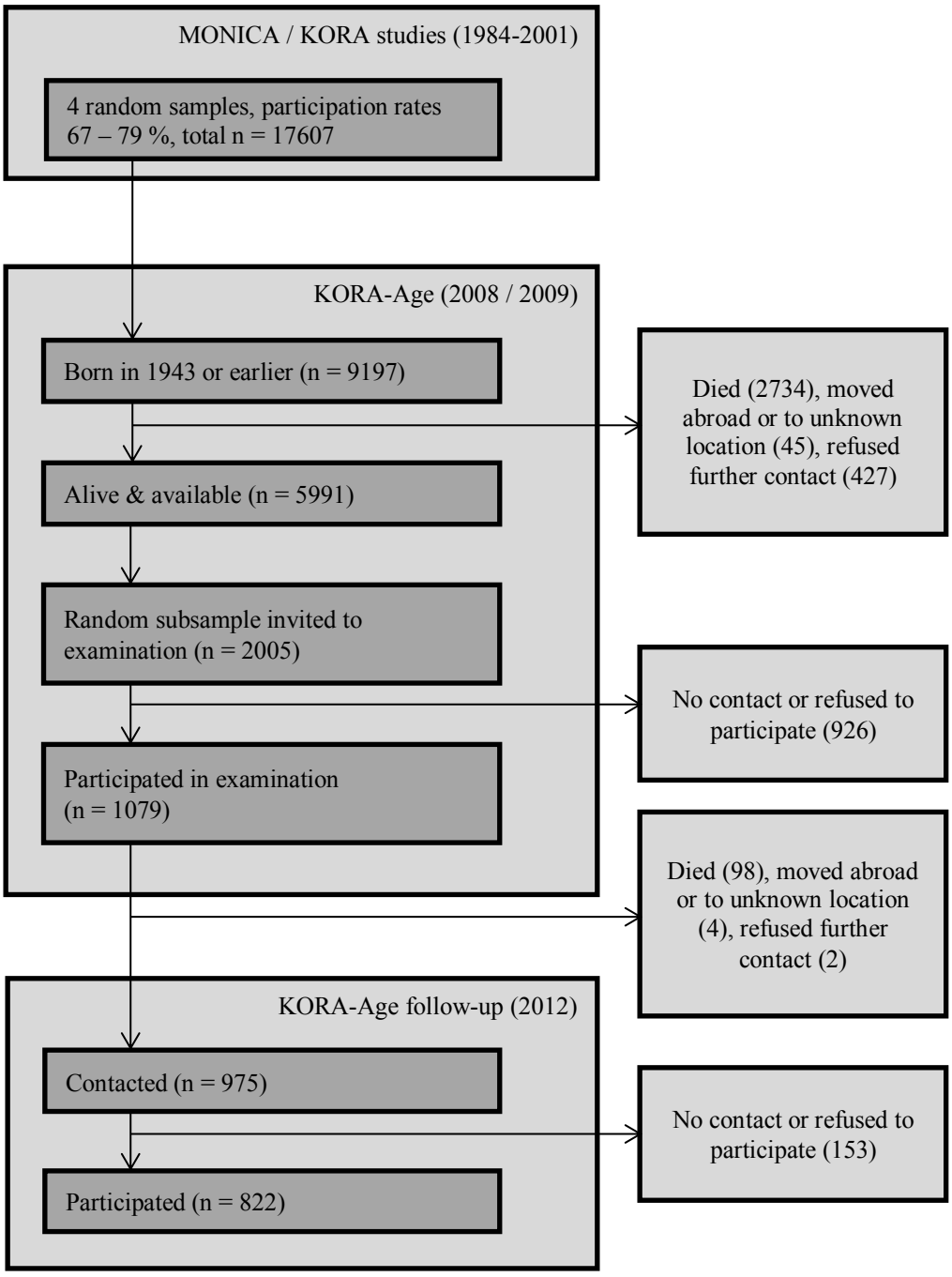

Fig. 1. Participant flow from MONICA / KORA studies to the KORA-Age follow-up.

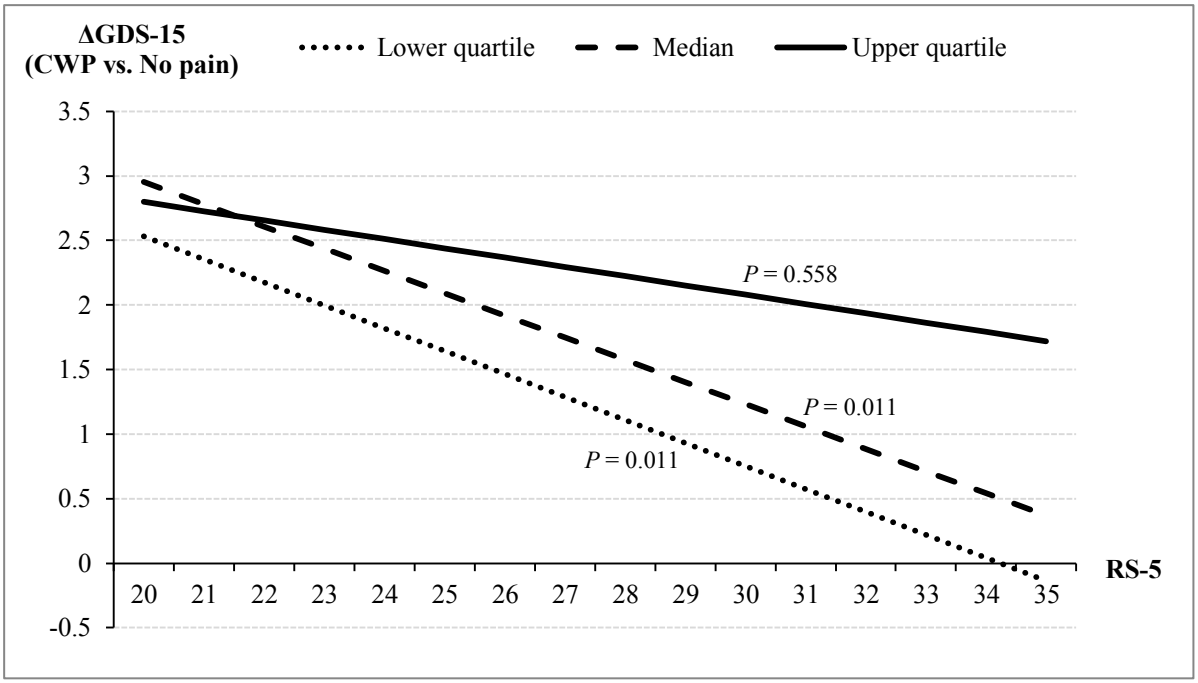

Fig. 2. Predicted differences in GDS-15 quartiles between CWP group vs. no pain group, by resilience score RS-5 (n = 724). The differences in group medians and lower quartiles decrease markedly with increasing resilience. P values indicate significance of interaction effects (cf. Table 3).

Table 1

Descriptive analysis of KORA-Age follow-up participants, in overall sample and stratified by pain status.

Variable		Overall (n = 724)	No Pain (n = 219)	Local Pain (n = 416)	Widespread Pain (n = 89)	*P* [a]
Sex	n (%)					<0.001 [b]
Male		359 (49.6)	135 (61.6)	191 (45.9)	33 (37.1)	
Female		365 (50.4)	84 (38.4)	225 (54.1)	56 (62.9)	
Age (yrs.)	mean (SD)	77.6 (6.1)	76.4 (6.1)	77.9 (6.1)	78.6 (6.1)	0.002 [c]
Vocational education degree	n (%)					0.013 [d]
None		163 (22.5)	36 (16.4)	103 (24.8)	24 (27.0)	
Basic		358 (49.5)	106 (48.4)	204 (49.0)	48 (53.9)	
Advanced		203 (28.0)	77 (35.2)	109 (26.2)	17 (19.1)	
Depression score (GDS-15)	mean (SD)	2.5 (2.6)	1.7 (2.0)	2.5 (2.5)	4.4 (3.2)	<0.001 [b]
Depressed mood (GDS-15 ≥ 5)	n (%)					<0.001 [b]
Yes		115 (15.9)	16 (7.3)	63 (15.1)	36 (40.5)	
No		609 (84.1)	203 (92.7)	353 (84.9)	53 (59.6)	
Resilience score (RS-5)	mean (SD)	29.0 (5.1)	29.3 (5.2)	29.0 (5.1)	28.4 (4.6)	0.111
Living with partner	n (%)					0.086 [e]
Yes		439 (60.6)	145 (66.2)	246 (59.1)	48 (53.9)	
No		285 (39.4)	74 (33.8)	170 (40.9)	41 (46.1)	
Body mass index (kg/m²)	mean (SD)	28 (4.2)	27.3 (3.9)	28.1 (4.1)	29.3 (5.3)	0.004 [c]
# of physical comorbidities	mean (SD)	2.4 (1.5)	1.8 (1.3)	2.6 (1.5)	3.2 (1.5)	<0.001 [b]
Stressful life event last year	n (%)					0.043 [d]
Yes		250 (34.5)	62 (28.3)	151 (36.3)	37 (41.6)	
No		474 (65.5)	157 (71.7)	265 (63.7)	52 (58.4)	
Cognitive function score (TICS-M)	mean (SD)	35.5 (5.5)	35.7 (5.8)	35.6 (5.4)	35.1 (5.5)	0.466
Trouble falling or staying asleep	n (%)					<0.001 [b]
Yes		312 (43.1)	66 (30.1)	194 (46.6)	52 (58.4)	
No		412 (56.9)	153 (69.9)	222 (53.4)	37 (41.6)	
Physically active	n (%)					0.002 [c]
Yes		402 (55.5)	142 (64.8)	219 (52.6)	41 (46.1)	
No		322 (44.5)	77 (35.2)	197 (47.4)	48 (53.9)	
Alcohol > once / wk.	n (%)					0.020 [d]
Yes		307 (42.4)	110 (50.2)	162 (38.9)	35 (39.3)	
No		417 (57.6)	109 (49.8)	254 (61.1)	54 (60.7)	
Opioid or regular NSAID use	n (%)					<0.001 [b]
Yes		70 (9.7)	7 (3.2)	42 (10.1)	21 (23.6)	
No		654 (90.3)	212 (96.8)	374 (89.9)	68 (76.4)	

GDS-15: Geriatric Depression Scale, 15 item version. RS-5: Resilience Scale, 5 item version. TICS-M: Modified Telephone Interview for Cognitive Status. [a] Categorical variables: Chi-square test, Quantitative variables: Kruskal-Wallis test; [b] $P < 0.001$. [c] $P < 0.01$. [d] $P < 0.05$. [e] $P < 0.1$.

Table 2

Association of pain status with depressive symptoms in logistic and quantile regression models of the GDS-15 score (n = 724).

		Adjusted for age and sex			Fully adjusted [a]		
		Estimate	95% CI	*P*	Estimate	95% CI	*P*
Logistic regression of depressed mood (GDS-15≥5) [b]							
Local pain		1.85	1.02; 3.35	0.043 [f]	1.36	0.72; 2.54	0.342
Widespread pain		6.91	3.45; 13.82	<0.001 [d]	4.08	1.90; 8.74	<0.001 [d]
Quantile regression of GDS-15 score [c]							
Local pain	Lower quartile	0.36	0.13; 0.59	0.003 [e]	0.15	-0.06; 0.35	0.163
	Median	0.51	0.10; 0.91	0.014 [f]	-0.17	-0.52; 0.18	0.333
	Upper quartile	0.54	-0.01; 1.09	0.054 [g]	-0.09	-0.53; 0.36	0.705
Widespread pain	Lower quartile	1.29	0.68; 1.89	<0.001 [d]	0.92	0.35; 1.49	0.002 [e]
	Median	2.51	1.62; 3.39	<0.001 [d]	1.14	0.20; 2.08	0.018 [f]
	Upper quartile	3.31	2.33; 4.28	<0.001 [d]	2.07	1.08; 3.07	<0.001 [d]

Reference category: No pain. [a] Adjusted for age, sex, vocational education, living status, BMI, # of physical comorbidities, stressful life event, cognitive status, sleeping problems, physical activity, alcohol use, and pain medication use. [b] Effects given as odds ratios. [c] Effects given as difference in score. [d] $P < 0.001$. [e] $P < 0.01$. [f] $P < 0.05$. [g] $P < 0.1$

Table 3

Interaction of resilience with pain status in quantile regression models of the GDS-15 score (n = 724).

		Estimate	95% CI	*P*
Pain status [a]				
Local pain	Lower quartile	0.11	-0.12; 0.34	0.347
	Median	0.03	-0.29; 0.35	0.840
	Upper quartile	0.03	-0.34; 0.40	0.871
Widespread pain	Lower quartile	0.75	0.18; 1.33	0.011 [e]
	Median	1.23	0.50; 1.96	0.001 [d]
	Upper quartile	2.08	1.02; 3.14	<0.001 [c]
Resilience score (RS-5) [b]	Lower quartile	-0.05	-0.09; -0.02	0.005 [d]
	Median	-0.12	-0.19; -0.06	<0.001 [c]
	Upper quartile	-0.20	-0.29; -0.11	<0.001 [c]
Interaction of RS-5 with... [a]				
Local pain	Lower quartile	-0.01	-0.06; 0.04	0.615
	Median	0.01	-0.07; 0.09	0.791
	Upper quartile	0.02	-0.09; 0.12	0.720
Widespread pain	Lower quartile	-0.18	-0.32; -0.04	0.011 [e]
	Median	-0.17	-0.30; -0.04	0.011 [e]
	Upper quartile	-0.07	-0.31; 0.17	0.558

Adjusted for age, sex, vocational education, living status, BMI, # of physical comorbidities, stressful life event, cognitive status, sleeping problems, physical activity, alcohol use, and pain medication use. Simple main effects given as difference in score. Interaction effects given as change of difference in score. [a] Reference category: No pain. [b] Centered at sample median (30). [c] $P < 0.001$. [d] $P < 0.01$. [e] $P < 0.05$.

Table 4

Interaction of resilience with pain status in logistic regression model of depressed mood (GDS-15 ≥ 5; n = 724).

Covariate	Estimate	95% CI	*P*
Pain status [a]			
Local pain	1.54	0.74; 3.21	0.244
Widespread pain	4.14	1.70; 10.09	0.002 [c]
Resilience score (RS-5) [b]	0.87	0.80; 0.95	0.002 [c]
Interaction of RS-5 with... [a]			
Local pain	1.04	0.94; 1.15	0.427
Widespread pain	0.94	0.80; 1.10	0.442

Adjusted for age, sex, vocational education, living status, BMI, # of physical comorbidities, stressful life event, cognitive status, sleeping problems, physical activity, alcohol use, and pain medication use. Simple main effects given as odds ratios. Interaction effects given as multiplicative change of odds ratios. [a] Reference category: No pain. [b] Centered at sample median (30). [c] $P < 0.01$.

Table S1

Comparison of participants having complete data in modelling variables (included in analysis; N = 724) with participants excluded from the analysis (N = 98).

Variable	N (%) missing		Overall	Included	Excluded	*P* [a]
Sex	0 (0)	n (%)				0.225
Male			414 (50.4)	359 (49.6)	55 (56.1)	
Female			408 (49.6)	365 (50.4)	43 (43.9)	
Age (yrs.)	0 (0)	mean (SD)	78.1 (6.4)	77.6 (6.1)	82.4 (6.7)	<0.001 [b]
Pain Status	44 (5.4)	n (%)				0.094 [e]
No Pain			243 (31.2)	219 (30.3)	24 (44.4)	
Local Pain			441 (56.7)	416 (57.5)	25 (46.3)	
Widespread Pain			94 (12.1)	89 (12.3)	5 (9.3)	
Vocational education degree	0 (0)	n (%)				<0.001 [b]
None			203 (24.7)	163 (22.5)	40 (40.8)	
Basic			400 (48.7)	358 (49.5)	42 (42.9)	
Advanced			219 (26.6)	203 (28.0)	16 (16.3)	
Depression score (GDS-15)	56 (6.8)	mean (SD)	2.5 (2.7)	2.5 (2.6)	3.7 (2.9)	0.001 [c]
Depressed mood (GDS-15 ≥ 5)	56 (6.8)	n (%)				0.011 d
Yes			128 (16.7)	115 (15.9)	13 (31.0)	
No			638 (83.3)	609 (84.1)	29 (69.1)	
Resilience score (RS-5)	59 (7.2)	mean (SD)	28.9 (5.2)	29.0 (5.1)	27.0 (6.5)	0.083 [e]
Living with partner	0 (0)	n (%)				0.010 [c]
Yes			485 (59.0)	439 (60.6)	46 (46.9)	
No			337 (41.0)	285 (39.4)	52 (53.1)	
Body mass index (kg/m²)	11 (1.3)	mean (SD)	28.0 (4.3)	28.0 (4.2)	28.5 (4.5)	0.250
# of physical comorbidities	4 (0.5)	mean (SD)	2.5 (1.5)	2.4 (1.5)	2.7 (1.4)	0.088 [e]
Stressful life event last year	1 (0.1)	n (%)				0.482
Yes			280 (34.1)	250 (34.5)	30 (30.9)	
No			541 (65.9)	474 (65.5)	67 (69.1)	
Cognitive function score (TICS-M)	72 (8.8)	mean (SD)	35.4 (5.6)	35.5 (5.5)	31.8 (6.1)	0.003 [c]
Trouble falling or staying asleep	2 (0.2)	n (%)				0.025 [d]
Yes			365 (44.5)	312 (43.1)	53 (55.2)	
No			455 (55.5)	412 (56.9)	43 (44.8)	
Physically active	15 (1.8)	n (%)				<0.001 [b]
Yes			426 (52.8)	402 (55.5)	24 (28.9)	
No			381 (47.2)	322 (44.5)	59 (71.1)	
Alcohol > once / wk.	1 (0.1)	n (%)				0.681
Yes			346 (42.1)	307 (42.4)	39 (40.2)	
No			475 (57.9)	417 (57.6)	58 (59.8)	
Opioid or regular NSAID use	1 (0.1)	n (%)				0.405
Yes			82 (10.0)	70 (9.7)	12 (12.4)	
No			739 (90.0)	654 (90.3)	85 (87.6)	

GDS-15: Geriatric Depression Scale, 15 item version. RS-5: Resilience Scale, 5 item version. TICS-M: Modified Telephone Interview for Cognitive Status. [a]

Categorical variables: Chi-square test, Quantitative variables: Wilcoxon rank sum test; [b] $P < 0.001$. [c] $P < 0.01$. [d] $P < 0.05$. [e] $P < 0.1$.

Table S2

Depression and resilience scores stratified by sex and age.

	Men				Women				Total			
	< 75 yr. (n = 140)	75 – 84 yr. (n = 172)	> 84 yr. (n = 47)	Total (n = 359)	< 75 yr. (n = 127)	75 – 84 yr. (n = 173)	> 84 yr. (n = 65)	Total (n = 365)	< 75 yr. (n = 267)	75 – 84 yr. (n = 345)	> 84 yr. (n = 112)	Total (n = 724)
Depression (GDS-15) score												
Mean	1.65	1.83	3.43	1.97	1.82	3.36	4.25	2.98	1.73	2.60	3.91	2.48
Median	1.00	1.00	3.00	1.00	1.00	2.50	3.00	2.00	1.00	2.00	3.00	2.00
Standard deviation	2.09	1.82	3.08	2.19	2.18	2.97	3.14	2.89	2.13	2.58	3.13	2.62
Skew	2.49	1.50	1.48	2.05	2.11	1.28	0.79	1.35	2.29	1.61	1.04	1.67
Kruskal-Wallis Test *P* value				<0.001 [a]				<0.001 [a]				<0.001 [a]
Resilience (RS-5) score												
Mean	29.14	29.27	29.06	29.19	29.88	28.73	27.46	28.90	29.49	29.00	28.13	29.05
Median	30.00	30.00	30.00	30.00	31.00	30.00	28.00	30.00	30.00	30.00	29.50	30.00
Standard deviation	5.11	4.76	5.19	4.94	4.23	5.42	5.81	5.17	4.72	5.10	5.59	5.06
Skew	-1.28	-1.06	-1.48	-1.20	-0.71	-1.10	-0.87	-1.04	-1.13	-1.10	-1.08	-1.12
Kruskal-Wallis Test *P* value				0.990				0.027 [b]				0.129

[a] $P < 0.001$. [b] $P < 0.05$.

Table S3

Covariate effects and model fit of logistic regression models of depressed mood (GDS-15≥5), with cumulative covariate adjustment (n = 724).

	Model 1			Model 2			Model 3			Model 4			Model 5			Model 6		
	Estimate	95% CI	*P*	Estimate	95% CI	*P*	Estimate	95% CI	*P*	Estimate	95% CI	*P*	Estimate	95% CI	*P*	Estimate	95% CI	*P*
Intercept	0.02	0.01; 0.05	-	0.03	0.01; 0.09	-	0.02	0.01; 0.06	-	0.03	0.01; 0.10	-	0.03	0.01; 0.09	-	0.02	0.01; 0.08	-
Pain status: Local Pain	1.85	1.02; 3.35	0.043[d]	1.87	1.03; 3.39	0.040[d]	1.52	0.82; 2.80	0.182	1.48	0.80; 2.75	0.209	1.43	0.77; 2.66	0.254	1.36	0.72; 2.54	0.342
Widespread pain	6.91	3.45; 13.82	<0.001[b]	7.00	3.48; 14.06	<0.001[b]	5.03	2.44; 10.38	<0.001[b]	4.90	2.36; 10.18	<0.001[b]	4.66	2.23; 9.77	<0.001[b]	4.08	1.90; 8.74	<0.001[b]
Age [years] (70)	1.11	1.07; 1.15	<0.001[b]	1.10	1.06; 1.14	<0.001[b]	1.08	1.04; 1.12	<0.001[b]	1.07	1.03; 1.11	0.001[c]	1.07	1.03; 1.12	<0.001[b]	1.05	1.01; 1.10	0.018[d]
Sex: Female	2.31	1.47; 3.63	<0.001[b]	1.96	1.15; 3.32	0.013[d]	1.88	1.10; 3.21	0.021[d]	1.84	1.07; 3.15	0.027[d]	1.81	1.05; 3.10	0.033[d]	2.08	1.17; 3.68	0.012[d]
Vocational education: Basic				1.04	0.61; 1.76	0.899	1.03	0.60; 1.76	0.929	1.08	0.62; 1.86	0.794	1.01	0.58; 1.76	0.966	1.00	0.57; 1.76	0.993
Advanced				0.92	0.46; 1.83	0.810	0.91	0.45; 1.83	0.787	0.95	0.47; 1.92	0.889	0.89	0.44; 1.81	0.751	0.87	0.43; 1.79	0.706
Living status: With partner				0.69	0.42; 1.11	0.125	0.64	0.39; 1.04	0.071[e]	0.60	0.37; 0.99	0.046[d]	0.64	0.39; 1.05	0.076[e]	0.64	0.39; 1.07	0.089[e]
Number of physical comorbidities (0)							1.36	1.16; 1.59	<0.001[b]	1.33	1.13; 1.55	<0.001[b]	1.31	1.12; 1.54	<0.001[b]	1.31	1.11; 1.55	0.001[c]
Physical Activity: ≥ 1 hr. / wk.										0.54	0.34; 0.87	0.011[d]	0.54	0.34; 0.87	0.011[d]	0.59	0.36; 0.95	0.030[d]
Stressful live event in last year: Yes													1.73	1.10; 2.72	0.018[d]	1.77	1.11; 2.81	0.017[d]
Sleeping Problems: Yes																1.15	0.73; 1.83	0.541
Body mass index [kg/m²] (25)																1.00	0.95; 1.05	0.987
TICS-M (36, = Sample median)																0.94	0.90; 0.99	0.011[d]
Alcohol use: More than once / wk.																1.07	0.65; 1.76	0.800
Pain medication use: Yes																1.91	1.01; 3.61	0.046[d]
Nagelkerke Pseudo-R^2 [a]	0.205	-	<0.001[b]	0.210	-	0.461	0.241	-	<0.001[b]	0.255	-	0.010[d]	0.266	-	0.018[d]	0.291	-	0.026[d]

Intercept: Estimated odds. Covariate effects: Estimated odds ratios. Quantitative variables are centered on value given in parentheses. Reference categories: Pain status: No Pain, Sex: Male, Vocational education: None, Living status: Without partner, Physical Activity: < 1hr. / wk., Stressful life event: No, Sleeping problems: No, Alcohol use: Less than once / wk., Pain medication use: No. [a] *P* value from likelihood ratio test against previous model (Model 1: Against null model). [b] $P < 0.001$. [c] $P < 0.01$. [d] $P < 0.05$. [e] $P < 0.1$

Table S4

Covariate effects and model fit of quantile regression models of GDS-15 score, with cumulative covariate adjustment (n = 724).

		Model 1			Model 2			Model 3			Model 4			Model 5			Model 6		
		Estimate	95% CI	*P*	Estimate	95% CI	*P*	Estimate	95% CI	*P*	Estimate	95% CI	*P*	Estimate	95% CI	*P*	Estimate	95% CI	*P*
Intercept	LQ	-0.29	-0.51; -0.06	-	-0.43	-0.78; -0.07	-	-0.59	-0.97; -0.20	-	0.00	-0.48; 0.48	-	0.32	-0.22; 0.86	-	0.24	-0.24; 0.72	-
	Med	0.21	-0.18; 0.60	-	0.27	-0.40; 0.95	-	-0.10	-0.65; 0.44	-	0.54	-0.11; 1.20	-	1.21	0.47; 1.95	-	1.19	0.47; 1.91	-
	UQ	1.15	0.68; 1.63	-	1.45	0.65; 2.25	-	1.00	0.19; 1.81	-	1.97	1.16; 2.78	-	2.33	1.36; 3.30	-	2.01	0.96; 3.05	-
Pain status: Local Pain	LQ	0.36	0.13; 0.59	0.003[c]	0.36	0.12; 0.59	0.003[c]	0.27	0.04; 0.50	0.022[d]	0.17	-0.06; 0.40	0.138	0.14	-0.09; 0.37	0.244	0.15	-0.06; 0.35	0.163
	Med	0.51	0.10; 0.91	0.014[d]	0.45	0.03; 0.88	0.035[d]	0.06	-0.31; 0.43	0.743	0.02	-0.32; 0.36	0.899	-0.06	-0.42; 0.29	0.731	-0.17	-0.52; 0.18	0.333
	UQ	0.54	-0.01; 1.09	0.054[e]	0.35	-0.20; 0.90	0.209	0.13	-0.41; 0.66	0.648	-0.10	-0.57; 0.37	0.673	-0.12	-0.62; 0.38	0.635	-0.09	-0.53; 0.36	0.705
Widespread pain	LQ	1.29	0.68; 1.89	<0.001[b]	1.28	0.65; 1.92	<0.001[b]	1.17	0.52; 1.83	<0.001[b]	1.22	0.64; 1.79	<0.001[b]	1.07	0.49; 1.65	<0.001[b]	0.92	0.35; 1.49	0.002[c]
	Med	2.51	1.62; 3.39	<0.001[b]	2.45	1.54; 3.37	<0.001[b]	1.96	1.09; 2.83	<0.001[b]	1.69	0.79; 2.60	<0.001[b]	1.51	0.62; 2.40	<0.001[b]	1.14	0.20; 2.08	0.018[d]
	UQ	3.31	2.33; 4.28	<0.001[b]	3.25	2.21; 4.29	<0.001[b]	2.38	1.31; 3.44	<0.001[b]	2.37	1.42; 3.32	<0.001[b]	2.23	1.31; 3.14	<0.001[b]	2.07	1.08; 3.07	<0.001[b]
Age [years] (70)	LQ	0.07	0.05; 0.09	<0.001[b]	0.07	0.05; 0.09	<0.001[b]	0.05	0.02; 0.07	<0.001[b]	0.04	0.02; 0.07	<0.001[b]	0.04	0.02; 0.06	<0.001[b]	0.02	0.00; 0.05	0.044[d]
	Med	0.10	0.07; 0.13	<0.001[b]	0.09	0.06; 0.12	<0.001[b]	0.08	0.05; 0.11	<0.001[b]	0.07	0.05; 0.10	<0.001[b]	0.07	0.05; 0.10	<0.001[b]	0.06	0.03; 0.09	<0.001[b]
	UQ	0.15	0.11; 0.20	<0.001[b]	0.15	0.10; 0.20	<0.001[b]	0.13	0.07; 0.18	<0.001[b]	0.10	0.06; 0.14	<0.001[b]	0.08	0.04; 0.12	0.001[c]	0.06	0.02; 0.10	0.004[c]
Sex: Female	LQ	0.43	0.20; 0.66	<0.001[b]	0.43	0.15; 0.71	0.003[c]	0.41	0.13; 0.70	0.005[c]	0.26	-0.01; 0.54	0.063[e]	0.29	0.03; 0.55	0.028[d]	0.29	0.05; 0.54	0.020[d]
	Med	0.69	0.34; 1.04	<0.001[b]	0.55	0.13; 0.96	0.010[d]	0.46	0.07; 0.85	0.022[d]	0.47	0.11; 0.82	0.011[d]	0.39	0.03; 0.75	0.034[d]	0.48	0.11; 0.85	0.011[d]
	UQ	0.85	0.30; 1.40	0.003[c]	0.60	0.01; 1.19	0.045[d]	0.75	0.19; 1.31	0.009[c]	0.63	0.17; 1.09	0.007[c]	0.64	0.10; 1.18	0.021[d]	0.65	0.18; 1.12	0.007[c]

Table continues on next page.

Table S4 (continued)

		Model 1			Model 2			Model 3			Model 4			Model 5			Model 6		
		Estimate	95% CI	*P*	Estimate	95% CI	*P*	Estimate	95% CI	*P*	Estimate	95% CI	*P*	Estimate	95% CI	*P*	Estimate	95% CI	*P*
Vocational education: Basic	LQ				0.14	-0.15; 0.44	0.344	0.10	-0.21; 0.40	0.527	0.13	-0.17; 0.42	0.388	0.11	-0.19; 0.41	0.478	0.07	-0.20; 0.33	0.612
	Med				0.18	-0.35; 0.71	0.503	0.25	-0.22; 0.72	0.299	0.17	-0.27; 0.61	0.455	0.08	-0.36; 0.52	0.725	0.04	-0.40; 0.47	0.873
	UQ				-0.05	-0.71; 0.61	0.882	-0.25	-0.95; 0.45	0.483	-0.27	-0.87; 0.33	0.373	-0.27	-0.94; 0.41	0.440	-0.18	-0.78; 0.41	0.541
Advanced	LQ				0.14	-0.19; 0.47	0.397	0.05	-0.29; 0.39	0.780	0.00	-0.33; 0.33	1.000	0.00	-0.33; 0.33	0.986	-0.03	-0.35; 0.29	0.853
	Med				-0.09	-0.66; 0.48	0.755	-0.09	-0.56; 0.37	0.701	-0.13	-0.59; 0.34	0.590	-0.31	-0.80; 0.17	0.206	-0.29	-0.78; 0.20	0.248
	UQ				-0.55	-1.24; 0.14	0.120	-0.75	-1.50; -0.00	0.049[d]	-0.77	-1.52; -0.02	0.043[d]	-0.65	-1.42; 0.12	0.096[e]	-0.49	-1.22; 0.25	0.195
Living status: With partner	LQ				-0.14	-0.42; 0.13	0.303	-0.17	-0.44; 0.09	0.207	-0.22	-0.47; 0.04	0.096[e]	-0.26	-0.52; -0.01	0.042[d]	-0.13	-0.38; 0.11	0.287
	Med				-0.18	-0.56; 0.20	0.351	-0.32	-0.72; 0.08	0.112	-0.37	-0.74; -0.01	0.047[d]	-0.20	-0.55; 0.14	0.247	-0.23	-0.59; 0.12	0.197
	UQ				-0.40	-0.96; 0.16	0.164	-0.50	-1.03; 0.03	0.062[e]	-0.50	-1.04; 0.04	0.070[e]	-0.65	-1.22; -0.09	0.024[d]	-0.52	-0.98; -0.07	0.025[d]
Number of physical comorbidities (0)	LQ							0.17	0.07; 0.27	<0.001[b]	0.13	0.03; 0.23	0.010[d]	0.14	0.05; 0.24	<0.001[b]	0.15	0.05; 0.24	0.002[c]
	Med							0.30	0.16; 0.43	<0.001[b]	0.25	0.13; 0.37	<0.001[b]	0.25	0.12; 0.37	<0.001[b]	0.24	0.10; 0.38	<0.001[b]
	UQ							0.38	0.21; 0.54	<0.001[b]	0.40	0.24; 0.56	<0.001[b]	0.43	0.25; 0.60	<0.001[b]	0.43	0.28; 0.57	<0.001[b]
Physical Activity: ≥ 1 hr. / wk.	LQ										-0.52	-0.77; -0.28	<0.001[b]	-0.54	-0.80; -0.27	<0.001[b]	-0.40	-0.61; -0.19	<0.001[b]
	Med										-0.64	-0.97; -0.32	<0.001[b]	-0.67	-1.01; -0.34	<0.001[b]	-0.59	-0.92; -0.26	<0.001[b]
	UQ										-1.00	-1.44; -0.56	<0.001[b]	-1.00	-1.49; -0.51	<0.001[b]	-0.76	-1.20; -0.33	<0.001[b]
Stressful life event in last year: Yes	LQ													0.39	0.15; 0.62	0.001[c]	0.38	0.16; 0.60	<0.001[b]
	Med													0.54	0.20; 0.88	0.002[c]	0.61	0.27; 0.96	<0.001[b]
	UQ													0.57	0.11; 1.04	0.015[d]	0.63	0.20; 1.05	0.004[c]

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Table S4 (continued)

		Model 1			Model 2			Model 3			Model 4			Model 5			Model 6		
		Estimate	95% CI	*P*	Estimate	95% CI	*P*	Estimate	95% CI	*P*	Estimate	95% CI	*P*	Estimate	95% CI	*P*	Estimate	95% CI	*P*
Sleeping Problems: Yes	LQ																0.30	0.07; 0.52	0.010[d]
	Med																0.32	-0.04; 0.67	0.078[e]
	UQ																0.16	-0.25; 0.57	0.450
Body mass index [kg/m²] (25)	LQ																-0.01	-0.04; 0.02	0.362
	Med																-0.03	-0.07; 0.01	0.101
	UQ																-0.01	-0.08; 0.05	0.683
TICS-M (36, = Sample median)	LQ																-0.03	-0.06; -0.01	0.003[c]
	Med																-0.04	-0.08; -0.01	0.014[d]
	UQ																-0.05	-0.09; -0.02	0.006[c]
Alcohol use: More than once / wk.	LQ																-0.19	-0.39; 0.01	0.067[e]
	Med																-0.15	-0.45; 0.16	0.344
	UQ																-0.18	-0.60; 0.24	0.401
Pain medication use: Yes	LQ																0.24	-0.31; 0.79	0.397
	Med																1.13	0.18; 2.08	0.019[d]
	UQ																1.15	0.06; 2.24	0.040[d]
Likelihood Ratio Test [a]	LQ	-	-	<0.001[b]	-	-	0.537	-	-	<0.001[b]	-	-	<0.001[b]	-	-	0.002[c]	-	-	<0.001[b]
	Med	-	-	<0.001[b]	-	-	0.359	-	-	<0.001[b]	-	-	<0.001[b]	-	-	0.003[c]	-	-	<0.001[b]
	UQ	-	-	<0.001[b]	-	-	0.100[e]	-	-	<0.001[b]	-	-	<0.001[b]	-	-	0.004[c]	-	-	<0.001[b]

LQ: Lower quartile. Med: Median. UQ: Upper quartile. Intercept: Estimated GDS-15 score. Covariate effects: Estimated difference in GDS-15 score. Quantitative variables are centered on value given in parentheses. Reference categories: Pain status: No Pain, Sex: Male, Vocational education: None, Living status: Without partner, Physical Activity: < 1hr. / wk., Stressful life event: No, Sleeping problems: No, Alcohol use: Less than once / wk., Pain medication use: No. [a] Test against previous model (Model 1: Against null model). [b] $P < 0.001$. [c] $P < 0.01$. [d] $P < 0.05$. [e] $P < 0.1$

Table S5

Pain status × Resilience score interaction effects in regression models of depressed mood and GDS-15 sc ore, stratified by age group.

		< 75 yr. (n = 267)			75 – 84 yr. (n = 345)			> 84 yr. (n = 112)		
		Estimate	95% CI	*P*	Estimate	95% CI	*P*	Estimate	95% CI	*P*
Logistic regression of de-pressed mood (GDS-15≥5) [a]										
Local pain		1.06	0.84; 1.32	0.632	1.09	0.90; 1.32	0.383	1.18	0.79; 1.78	0.421
Widespread pain		1.12	0.86; 1.47	0.406	0.89	0.67; 1.16	0.386	1.13	0.69; 1.84	0.634
Quantile regression of GDS-15 score [b]										
Local pain	Lower quartile	0.05	-0.03; 0.13	0.227	0.01	-0.05; 0.07	0.662	0.06	-0.35; 0.47	0.786
	Median	0.08	-0.03; 0.20	0.154	0.01	-0.09; 0.10	0.888	0.37	-0.03; 0.78	0.071
	Upper quartile	0.09	-0.05; 0.24	0.212	0.08	-0.11; 0.26	0.409	0.16	-0.34; 0.66	0.532
Widespread pain	Lower quartile	0.11	-0.16; 0.38	0.435	-0.18	-0.37; -0.00	0.048	-0.27	-0.90; 0.36	0.396
	Median	0.07	-0.27; 0.41	0.686	-0.19	-0.39; 0.00	0.055	0.20	-0.38; 0.79	0.492
	Upper quartile	0.09	-0.44; 0.62	0.747	-0.17	-0.58; 0.24	0.404	0.15	-0.50; 0.80	0.647

Reference category: No pain. All models adjusted for age, sex, vocational education, living status, BMI, # of physical comorbidities, stressful life event, cognitive status, sleeping problems, physical activity, alcohol use, and pain medication use. [a] Effects given as multiplicative change of odds ratios. [b] Effects given as change of difference in score. [c] $P < 0.001$. [d] $P < 0.01$. [e] $P < 0.05$. [f] $P < 0.1$