Education, job position, income or multidimensional indices? The influence of different indicators of socioeconomic status on low back pain in a German sample

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Education, job position, income or multidimensional indices? The influence of different indicators of socioeconomic status on low back pain in a German sample

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ABSTRACT:

Objectives: Comparison of the influence of most common socioeconomic status (SES) indicators (education, job position, income, multidimensional index) on intermitted low back pain in a single sample.

Design: Longitudinal observational study

Setting: Four medical clinic sides in Germany

Participants: 381 people. Inclusion criteria: 1) age 18 to 65, 2) able to understand the meaning of the study and to complete a questionnaire without help.

Exclusion criteria: 1) pregnancy, 2) serious pain syndromes in the last 3 month, 3) inability to stand upright, 4) inability to give sick leave information, 5) signs of serious spinal pathology, 6) not completed all relevant questions needed for the different SES operationalisations.

Outcome measures: Intensity of intermitted low back pain (LBP) and disability because of intermitted LBP.

Results: Hierarchical linear regression revealed that for LBP intensity the multidimensional index (*beta*=-0.12, *p*<0.01), job position (*beta*=0.11, *p*=0.01) and education (*beta*=-0.10, *p*<0.05) had equally high impacts. Income had no significant influence (*beta*=0.04, n.s.). For LBP disability the multidimensional index (*beta*=-0.21, *p*<0.01) and job position (*beta*=0.20, *p*<0.01) had the highest influence. Education (*beta*= -0.13, *p*<0.01) and income (*beta*=-0.13, *p*=0.01) had equal but less strong impacts.

Conclusion: The results reveal that different indicators have different strong influences on intermitted LBP and therefore should not be treated interchangeably. Job position is the most important single indicator. Prevention and intervention work therefore should focus on the areas influences by job position. In general more research on the relationship between SES and health outcomes is needed.

STRENGTHS AND LIMITATIONS OF THIS STUDY:

- The paper expands the analysis of the influence of different indicators of the SES on a subject not yet investigated under this aspect, namely intermitted low back pain.
- Various regression models with the identical sample are performed to highlight how much the predicted influence between SES and the health output may vary if only one SES indicator is taken into account.
- Furthermore the paper introduces a theoretical framework dedicated to support researchers in choosing the most suitable indicator for their research question.
- The results are limited by the fact that the chosen theoretical framework may be too simple.

BACKGROUND

It is widely accepted in health sciences that the socioeconomic status (SES) is linked to many health outcomes [1]. However, less is known about the causal pathways and mediating factors that lead from SES to these outcomes. This gap in research seems to be at least partly caused by unresolved methodological issues concerning the operationalization of SES. Since SES is a latent construct, various indicators are used to measure a person's SES. The most commonly used indicators are education, job position, income or combinations of these variables [2]. The decision for a specific SES indicator is often not adequately justified in articles [3], and they are even used interchangeably [1]. This limits the interpretation of research results: Different operationalizations are based on different theoretical explanatory models connecting the SES-indicators and health outcomes. Job position for example is thought to be connected with the amount of stress someone has to face, which may influence his health, whereas education influences the knowledge someone has about health [4]. As a consequence, it is very likely that different operationalizations will influence the predicted strength between SES and a specific health outcome. This indeed has been confirmed for several health domains such as myocardial infarctions [5], overall mortality [5, 6], diabetes [5] or subjective health status [7, 8]. From these studies two things are noteworthy: First of all, there is no single SES indicator that always has the strongest influence on health outcomes. This means that instead of advocating the use of one SES indicator over another, ideally, separate analyses in every health domain would be needed to determine which indicators are the most relevant. Secondly, in studies investigating the link between SES and health outcomes, these differences in influence are rarely acknowledged [3]. However, if we want to fully understand the relationship between SES and different health outcomes, we not only need to know whether different indicators differ in influence, but also try to understand why this is so. Ultimately, this would enable prevention and interventions efforts to more efficiently target the most relevant factors. In this article these questions will be addressed in a health domain that has rarely been studied in this context, intermitted low back pain (LBP).

LBP seems a suitable health outcome to take a closer look at it regarding its connection to SES: It is a mayor public health burden with a worldwide lifetime prevalence of about 39 percent, whereby about 20 percent of people suffer from chronic low back pain [9]. Moreover, it has a multidimensional aetiology with interactions between health behaviour [10] and different social [11] and psychological factors [12]. This makes it very plausible that different SES indicators would lead to different degrees of influence. However, as with other health outcomes, researchers investigating the influence of SES on back pain have used a variety of different SES indicators, often without explaining their choice [3]. To date, one study by Latza and colleagues have compared different SES indicators and their relative influence on self-reported back pain. They found that education had the strongest impact on severe back pain, followed by job position and income [13]. Crucially however, the study did not use identical samples for all their SES predictors, making it difficult to determine whether the observed differences in influences were caused by the SES indicator or by differences in the sample. Therefore, a study that investigates the link between different SES indicators and LBP in a single sample is needed to understand the influence of different SES indicators on back pain.

For the evaluation of the most important indicator on LBP, a closer look at the factors that mediate the relationship between SES and health outcomes is needed [4]. According to the well-established model of social determinants of health by Brunner and Marmot [14], there are three groups of mediating factors between SES and health: Material factors (e.g. pollution), social and psychological factors (e.g. stress) and health behaviour (e.g. dietary habits). Translating this general model to the current example, prior research has revealed that chronic LBP is strongly associated with social and psychological factors such as depressive symptoms [15] stress [16] or working conditions [17]. Additionally, health behaviour plays an, albeit minor, role [18, 19]. The third group of factors, material factors, have not been found to be associated with chronic LBP in in previous studies. Based on these findings, it can be assumed that the SES indicators that are most closely associated with the two groups of mediating factors related to LBP, social and psychological factors and health behaviour, exert stronger influence on LBP. Hradil, examining the influence of SES indicators on cardiovascular diseases, has proposed such connections between SES indicators and the mediating factors in question [4]: He assumes job position to be strongly connected with social and psychological factors, education with health behaviour and income with material factors. Applying these insights to LBP we hypothesise that job position is most strongly connected with LBP, followed by education. Income should have the weakest influence. The multidimensional index, covering all possible pathways, should be most influential.

METHOD

Sample: Participants were recruited in four medical clinic sides in Germany as part of a large study on low back pain (Medicine in Spine Network, [20]). Inclusion criteria were: 1) age 18 to 65, 2) able to understand the meaning of the study and to complete a questionnaire without help. Exclusion criteria were 1) pregnancy, 2) inability to stand upright, 3) inability to give sick leave information, 4) signs of serious spinal pathology. To ensure homogeneity in the here presented research question, all participants who failed to complete all relevant questions needed for the different SES operationalisations were excluded. Additionally all people who did not have a job at the time of the study were excluded, as it would not be possible to create the indicator job position for them. Furthermore, since new onset of LBP was in the focus of this study, all people who already reported serious chronic pain syndromes at baseline were excluded. This led to a final sample of *N*=381 participants.

Testing procedure: All measurements were performed at medical clinics. After baseline, people were again questioned 6 month later. Written consent was granted by all participants. The survey was approved by ethics committee of University of Potsdam (Ethics approval 36/2011) and is in accordance with the principles of the Declaration of Helsinki.

Instruments and data pre-processing:

SES indicators: Socioeconomic status was evaluated at baseline using the following instruments:

Education was assessed using the International Standard Classification of Education (ISCED), which combines school and vocational education [21], resulting in a score from 0 (less than primary education) to 5 (tertiary education).

Job position was measured using the nine categories of the International Standard Classification of Occupation (ISCO-08), combining jobs according to main tasks, skill level and specialisation [22].

Monthly net income was asked using 7 categories (less than 1 250€, 1 250€ to 1 749€, 1 750€ to 2 249€, 2 250€ to 2 999€, 3 000€ to 3 999€, 4 000€ to 4 999€, 5 000€ and more).

Multidimensional SES index was calculated using the Winkler-Scheuch-Index (WS-index). This index, recommended by the German Working Group for Social Epidemiology [23], is based on the three dimensions: education, job position and income. Each person gets a value between 1 and 7 for each of the single indicators. The total of these three values then determines the person's score in the WS-index, from 3 (lowest SES) to 21 [23].

Pain indicators:

Pain intensity was evaluated using the Chronic Pain Grade questionnaire (CPG) created by von Korff [24], asking about the current intensity of pain, the average intensity in the last three months and the worst experienced pain in the last three months. Answering options ranged from 0 (no pain) to 10 (worst pain possible). The mean of these three questions was calculated and multiplied by 10, resulting in a score of 0 to 100 for each participant. These variables were collected at baseline and follow up. Internal consistency was good for both measurement points (baseline: *Cronbach's Alpha*=0.76; follow up: *Cronbach's Alpha*=0.82).

Pain disability was also evaluated using three questions of the CPG questionnaire asking about how much the pain interfered with daily activities, recreational and social activities and with work (again rated on a scale from 0 to 10). The mean of these three questions was calculated and the result multiplied by 10 resulting in a score from 0 to 100 [24]. Internal consistency was excellent (baseline: *Cronbach's Alpha*: 0.87; follow up: *Cronbach's Alpha*=0.93).

Pain Class: To enable focussing on new onsets of back pain only, a pain classification index was used at baseline (CPG pain classes). This scale grades pain intensity, pain disability and the number of days with limitations because of pain into 5 categories: 0: no pain; 1 pain with low intensity and low disability; 2 low disability but high intensity; 3 high disability with few days of limitation in everyday life; 4 high disability with severe limitation in everyday life [24]. For the present study, only participants with pain class 0 or 1 at baseline were included.

Statistical analysis: After descriptives, four hierarchical regression analyses were conducted for each pain outcome using either education, job position, monthly net income or the multidimensional index as the respective predictors while controlling for age, sex and pain at baseline. Requirements of the regression analysis were tested with collinearity diagnosis, Durbin-Watson test and Kolmogorov Smirnoff test for normality of residuals. All analyses were performed with IBM SPSS Statistics 21.

RESULTS

Descriptives: Looking at the characteristics of the sample Table 1 reveals that respondents (55.1 percent women) were on average middle-aged, covering the whole spectrum of the age range. On average participants were highly educated and held high job positions. The average income in the sample was between 1750 and 2249 Euros and the WS-index was on average 14.9 on the scale from 3 to 21. Pain intensity and disability was low at t0 and t1.

Table 1: Characteristics of study sample (*N*=381):

Variable (range)	M	SD	MIN.	MAX.
Age (18 to 65)	41.0	11.8	19	65
Education (1 to 5)	4.1	0.9	1	5
Jobposition (1 to 9)	3.3	2.0	1	9
Income (1 to 7)	3.3	1.8	1	7
Winkler-Scheuch Index (3 to 21)	14.9	2.9	8.2	20.4
CPG pain intensity baseline (0 to 100)	21.0	13.8	0	47
CPG pain intensity follow up (0 to 100)	19.4	16.7	0	67
CPG disability baseline 0 to 100)	9.9	12.7	0	63
CPG disability follow up (0 to 100)	9.7	15.6	0	90
CPG pain class baseline	0.9	0.3	0	1

Regression models:

Starting with the models for the prediction of pain intensity (Table 2), three SES indicators (namely education, job position and the WS-index) were able to explain significant variance. Comparing the strength of these respective SES indicators, the ranking is as follows: WS-index (beta=-0.12), job position (beta=0.11) and education (beta=-0.10). People with higher overall SES, higher job positions and higher education experience on average less intense pain. Change in R^2 due to these variables vary between 0.012 (job position and WS-index) and 0.009 (education). Income showed no significant influence. The high absolute R^2 is partly caused by the strong impact of the control variable pain intensity at first measurement point (highly significant beta of 0.53, not indicated in the table).

Table 2: Hierarchical regression models predicting influence of different operationalisations of SES on CPG pain intensity score (higher values more pain), controlled for age, sex and baseline pain intensity (*N*=381):

MODEL	SES INDICATOR	R^2	ΔR^2	BETA	T-VALUE	P
1	Education	0.32	0.009*	-0.10	-2.29	0.02*
2	Job position	0.32	0.012*	0.11	2.57	0.01*
3	Income	0.31	0.002	-0.04	-0.91	0.36
4	WS-index	0.32	0.012*	-0.12	-2.63	<0.01**

* = p<0.05; ** = p<0.01

The situation is different for the models for pain disability (Table 3). All four predictor variables exert significant influence on disability. Moreover, they all had a higher impact in comparison to their impact on pain intensity. The strongest predictor was the WS-index (beta=0.21), followed by job position (beta=0.20), education (beta=-0.13) and income (beta=-0.13): People with higher combined socioeconomic status, higher job position, higher education and higher income report on average less disability because of pain. Change in R^2 varies between 0.039 (WS-index) and 0.014 (income).

Table 3: Hierarchical regression models predicting influence of different operationalisations of SES on CPG disability (higher values, more disability), controlled for age, sex and baseline pain intensity (*N*=381):

MODEL	SES INDICATOR	R^2	ΔR^2	BETA	T-VALUE	P
1	Education	0.14	0.017*	-0.13	-2.77	<0.01**
2	Job	0.16	0.038*	0.20	4.14	<0.01**
3	Income	0.14	0.014*	-0.13	-2.48	0.01*
4	WS-index	0.16	0.039*	-0.21	-4.20	<0.01**

* = p<0.05; ** = p<0.01

DISCUSSION

The purpose of this study was to evaluate whether the influence of SES on intermitted LBP changes as a function of the used SES indicator.

It was found that there are indeed differences in the predictive power of commonly used SES indicators. Although it is unlikely to overlook the connection between SES and back pain completely (since all indicators except for income on pain intensity exert significant influence), there were differences in the predictive strength of the SES indicators for pain disability, which could mean that the SES predictor should be selected carefully in order to not underestimate the influence of SES on back pain. Based on the results of this study, it appears that job position would be the most appropriate SES indicators to use in studies on intermitted low back pain. In general however, only income could be clearly identified as suboptimal predictor. In this respect the current findings differ from studies in other health domains that compared the relative impact of SES predictors. For example Geyer and colleagues [5] found education to be a much stronger predictor for diabetes than job position and income to predict better overall mortality than education and job position, whereas Miech and colleagues [7] revealed education as stronger predictors for subjective health than education. This was not confirmed by Geyer [8], who found income and job position to influence subjective health stronger than education. This emphasizes the importance of rethinking possible pathways between SES indicators and health for every health outcome in question.

With regard to predicting the relative influence of the various SES predictors, the findings only partially support the predicted associations. Starting with pain intensity, it was hypothesized that the multidimensional index and job position, followed by education should be the most influential predictor, whereas income should play no or just a small role. As predicted, income shows no significant influence and is not able to predict pain intensity. But other than assumed, the multidimensional index (*beta*=-0.12,), job position (*beta*=0.11) and education (*beta*=-0.09), are (nearly) equally strong predictors for pain intensity. The reason for this may be that the model was oversimplifying when assigning the SES indicators to separate mediating pathways (e.g. job position exclusively to psychosocial, and education exclusively to health behaviour). Education also influences psychosocial conditions and job position also affects health behaviour as prior research has shown [25, 26] . Finally, a priori it was assumed that the WS-index, combining the influences of the single indicators should have significantly more impact. This was not the case in the present study. It appears that the impact of the single dimensions do not necessarily add up in such a way that people scoring high in more than one dimension have a remarkably lower risk of developing back pain and people scoring low a higher risk, something Geyer [8] already showed in a different health domain. The reason for this may be the inter-relatedness of the indicators and the mediating factors, leading to a shared influence on back pain for all indicators.

For the outcome pain disability, the results are again only partly in line with the hypothesis: First of all, job position (*beta*=0.20) is, as expected, the strongest predictor out of the single indicators, but the multidimensional index (*beta*=-0.21) is as strong. Again it appears to be wrong to assume that the impact of the single dimensions simply will add up. With regard to education (*beta*=-0.13), the results are in line with the assumptions: Education predicts pain disability, but not as well as job position or the WS-index. Income (*beta*=-0.13) has, other than expected, also a significant influence on pain disability. Here the assumption that material factors play no role for pain disability seems to be wrong: a possible explanation may be that a higher income enables people to acquire material resources which reduce their disability in everyday life.

To our knowledge this is the first study that has compared the predictive strength of various SES indicators on intermitted LBP in a single sample, thereby adding to the literature that advocates a critical and careful selection of SES indicators. While the results of this and other studies suggest that the SES indicator should be carefully selected and should not be used interchangeably, it has proven to be difficult to predict beforehand which SES indicator will be the most appropriate. In this study the pathways described in the model by Brunner and Marmot [14] was used to predict the influence of the various SES indicators, however the findings were not fully in line with these predictions. A reason for this may be that the predictions were based on a simplified reflection of reality, assuming no intercorrelations between the different variables.

Nonetheless, since the article stresses the importance of careful SES indicator selection, further research should aim to develop frameworks to aid researchers in selecting the appropriate SES indicator for their research question. Ultimately such frameworks will help to improve the understanding of the link between SES and health.

AUTHOR CONTRIBUTION

All authors substantially contributed to the conception and realization of this article. MF conceived and wrote the first draft of this manuscript and provided the statistical analysis. JW and PW revised the manuscript. PW was responsible for the psychometric design, analysis plan and conceived the social methods of the study. All authors read and approved the final manuscript.

COMPETING INTERESTS:

The authors declare that they have no competing interests.

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ETHICAL APPROVAL

The study was approved by the Independent ethics committee of University of Potsdam (Ethics approval 36/2011).

DATA SHARING:

No additional data available

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REFERENCES

1 Cundiff JM, Uchino BN, Smith TW, et al. Socioeconomic status and health: education and income are independent and joint predictors of ambulatory blood pressure. *J Behav Med* 2015;38(1):9–16.

2 Nocon M, Keil T, Willich SN. Education, income, occupational status and health risk behaviour. *J Public Health* 2007;15(5):401–05.

3 Fliesser M, Klipker K, Wippert P-M. Zur Verwendung des soziookonomischen Status in der Gesundheitsforschung am Beispiel Ruckenschmerz - systematisches Review. *Gesundheitswesen* 2016.

4 Hradil S. Was prägt das Krankheitsrisiko- Schicht, Lage, Lebensstil? In: Richter M, Hurrelmann K, eds. Gesundheitliche Ungleichheit: Grundlagen, Probleme, Perspektiven, 2nd edn. Wiesbaden: VS, Verl. für Sozialwiss 2009:33–52.

5 Geyer S, Hemström O, Peter R, et al. Education, income, and occupational class cannot be used interchangeably in social epidemiology. Empirical evidence against a common practice. *J Epidemiol Community Health* 2006;60(9):804–10.

6 Stringhini S, Dugravot A, Kivimaki M, et al. Do different measures of early life socioeconomic circumstances predict adult mortality? Evidence from the British Whitehall II and French GAZEL studies. *J Epidemiol Community Health* 2011;65(12):1097–103.

7 Miech RA, Hauser RM. Socioeconomic Status and Health at Midlife: A Comparison of Educational Attainment with Occupation-Based Indicators. *Annals of Epidemiology* 2001;11(2):75–84.

8 Geyer S. Einzelindikator oder Index? Masse sozialer Differenzierung im Vergleich. *Gesundheitswesen* 2008;70(5):281–88.

9 Hoy D, Bain C, Williams G, et al. A systematic review of the global prevalence of low back pain. *Arthritis Rheum* 2012;64(6):2028–37.

10 van Hecke O, Torrance N, Smith BH. Chronic pain epidemiology - where do lifestyle factors fit in? *Br J Pain* 2013;7(4):209–17.

11 Goldberg DS, McGee SJ. Pain as a global public health priority. *BMC Public Health* 2011;11:770.

12 van Hecke O, Torrance N, Smith BH. Chronic pain epidemiology and its clinical relevance. *Br J Anaesth* 2013;111(1):13–18.

13 Latza U, Kohlmann T, Deck R, et al. Influence of Occupational Factors on the Relation Between Socioeconomic Status and Self-Reported Back Pain in a Population-Based Sample of German Adults With Back Pain. *Spine* 2000;25(11):1390–97.

14 Brunner G, Marmot MG. Social organisation, stress, and health. In: Marmot MG, Wilkinson RG, eds. Social determinants of health, 2nd edn. Oxford, New York: Oxford University Press 2011:6–30.

15 Bair MJ, Robinson RL, Katon W, et al. Depression and pain comorbidity: A literature review. *Arch Intern Med* 2003;163(20):2433–45.

16 Hoy D, Brooks P, Blyth F, et al. The Epidemiology of low back pain. *Best Pract Res Clin Rheumatol* 2010;24(6):769–81.

17 Chou R, Shekelle P. Will this patient develop persistent disabling low back pain? *JAMA* 2010;303(13):1295–302.

18 Brox JI, Storheim K, Holm I, et al. Disability, pain, psychological factors and physical performance in healthy controls, patients with sub-acute and chronic low back pain: a case-control study. *J Rehabil Med* 2005;37(2):95–99.

19 Melloh M, Elfering A, Egli Presland C, et al. Identification of prognostic factors for chronicity in patients with low back pain: a review of screening instruments. *Int Orthop* 2009;33(2):301–13.

20 Wippert P-M, Puschmann A-K, Drießlein D, et al. Development of a Risk Stratification Index and a Risk Prevention Index for chronic low back pain in primary care. Focus: yellow flags (MiSpEx Network). *PAIN-Reports* pub. ahead.

21 UNESCO. International standard classification of education: ISCED 2011. Montreal, Quebec: UNESCO Institute for Statistics 2012.

22 Statistik Austria. ISCO 08- gemeinsame deutschsprachige Titel und Erläuterungen 2011. Available at: http://www.statistik.at/wcm/idc/idcplg?IdcService=GET_PDF_FILE&dDocName=049974.

23 Lampert T, Kroll LE, Müters S, et al. Messung des sozioökonomischen Status in der Studie "Gesundheit in Deutschland aktuell" (GEDA). *Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz* 2013;56(1):131–43. 23275948.

24 Korff M, Ormel J, Keefe FJ, et al. Grading the severity of chronic pain. *Pain* 1992;50(2):133–49.

25 Gallo LC, Matthews KA. Understanding the association between socioeconomic status and physical health: Do negative emotions play a role? *Psychological Bulletin* 2003;129(1):10–51.

26 Lipowicz A, Szklarska A, Malina RM. Allostatic load and socioeconomic status in Polish adult men. *J Biosoc Sci* 2014;46(2):155–67.

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Education, job position, income or multidimensional indices? Associations between different socioeconomic status indicators and intermitted low back pain in a German sample: a longitudinal field study

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Education, job position, income or multidimensional indices? Associations between different socioeconomic status indicators and intermitted low back pain in a German sample: a longitudinal field study

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ABSTRACT:

Objective: Investigation of associations between common socioeconomic status (SES) indicators (education, job position, income, multidimensional index) on intermitted low back pain (LBP) in a single sample.

Design: Longitudinal field study

Setting: Four medical clinics across Germany

Participants: 352 people. Inclusion criteria: 1) age 18 to 65, 2) able to understand the meaning of the study and to complete a questionnaire without help.

Exclusion criteria: 1) pregnancy, 2) inability to stand upright, 3) inability to give sick leave information, 4) signs of serious spinal pathology, 5) not completed all relevant questions needed for the different SES operationalisations and 6) serious pain syndromes in the last 3 months.

Outcome measures: Intensity of intermitted LBP and disability due to intermitted LBP.

Results: Hierarchical linear regression of four different models for each dependent variable revealed job position to be the best predictor for LBP intensity followed by the multidimensional index, whereas education and income had no impact. For LBP disability, again job position proved the best predictor followed by the multidimensional index and education, while income had no significant association.

Conclusion: The results revealed that several SES indicators have strong, but different associations with intermitted LBP and are therefore not interchangeable. Job position was found to be the single most important indicator. Prevention and interventions should thus focus on areas influenced by job position. In general, more research on the relationship between SES and health outcomes is needed.

STRENGTHS AND LIMITATIONS OF THIS STUDY:

- The extension of SES indicator analysis to a new patient pathology, namely intermitted low back pain (LBP).
- The comparison of various regression models performed on the identical sample to highlight exact variations in the predicted associations between SES and LBP.
- Results could be limited due to the relatively small group sizes and because only four SES indicators were taken into account.
- Transferability of results to other health settings and countries still has to be proven.
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BACKGROUND

It is widely accepted in health sciences that socioeconomic status (SES) is linked to many health outcomes [1]. However, less is known about the causal pathways and mediating factors that lead from SES to these outcomes. This gap in research seems to be at least partly caused by unresolved methodological issues concerning the operationalization of SES. Because SES is a latent construct, various indicators are used to measure a person's SES. The most commonly used indicators are education, job position, income or combinations of these variables [2]. The justification for using a specific SES indicator is often not adequately justified in articles [3], and they are even used interchangeably [4]. This limits the interpretation of research results: Different operationalizations are based on different theoretical explanatory models connecting SES-indicators and health outcomes. Job position, for example, is thought to be connected with stress, which may influence health, whereas education influences knowledge about health [5]. As a consequence, it is very likely that different operationalizations will influence the predicted association between SES and a specific health outcome. This has indeed been confirmed for several health domains such as myocardial infarctions [6], overall mortality [6, 7], diabetes [6] and subjective health status [8, 9]. From these studies, two things are noteworthy. First, there is no single SES indicator that always has the strongest influence on health outcomes. This means that instead of advocating the use of one SES indicator over another, ideally, separate analyses in every health domain would be needed to determine which indicators are the most relevant. Secondly, in studies investigating the link between SES and health outcomes, these differences in influence are rarely acknowledged [3]. However, if we want to fully understand the relationship between SES and different health outcomes, we not only need to know whether different indicators differ in their association, but also to try and understand why this is so. Ultimately, this would enable prevention and intervention efforts to more efficiently target the most relevant factors. In this article, these questions will be addressed in a health domain that has rarely been studied in this context, intermitted low back pain (LBP).

LBP seems a suitable health outcome to investigate regarding its connection to SES. LBP is a major public health burden with a worldwide lifetime prevalence of about 39 %, whereby about 20 % of people suffer from chronic LBP [10]. Moreover, it has a multidimensional aetiology with interactions between health behaviour [11] and different social [12] and psychological factors [13]. This makes it very plausible that different SES indicators would lead to different degrees of association. However, as with other health outcomes, researchers investigating the influence of SES on back pain have used a variety of different SES indicators, often without explaining their choice [3]. To date, one study by Latza and colleagues compared different SES indicators and their relative influence on self-reported back pain. They found that education had the strongest impact on severe back pain, followed by job position and income [14]. However, and this is crucial, the study did not use identical samples for all SES predictions, making it difficult to determine whether the observed differences were caused by the SES indicators or by differences in the samples. Therefore, a study investigating the link between different SES indicators and LBP in a single sample is needed to best understand possible associations.

For evaluation of the most important indicators in LBP, a closer look at the factors mediating the relationship between SES and health outcomes is needed [5]. According to the well-established model of social determinants of health by Brunner and Marmot [15], there are three groups of mediating factors between SES and health: material factors (e.g. pollution), social and psychological factors (e.g. stress) and health behaviour (e.g. dietary habits). Translating this general model to the current example, prior research revealed that chronic LBP is strongly associated with social and psychological factors such as depressive symptoms [16], stress [17] and dissatisfaction with work organisation [18]. Additionally, health behaviour plays a role, albeit minor [19, 20]. The third group of factors, material factors, have not been found to be associated with chronic LBP in previous studies. Based on these findings, it can be assumed that SES indicators most closely associated with social and psychological factors and health behaviour exert stronger influence on LBP. Hradil et al., examining the influence of SES indicators on cardiovascular diseases, assumed job position to be most strongly connected with social and psychological factors, education with health behaviour and income with material factors [5]. Using these assumptions, we hypothesise that from the single indicators job position will be strongly associated with LBP, followed by education. Income, we believe, will have the weakest, if any, association. The multidimensional index, covering all possible pathways, should however yield the greatest predictive power.

METHOD

Sample: Participants were recruited in four medical clinics across Germany as part of a national study on LBP (Medicine in Spine Network, [21]). Inclusion criteria consisted of: 1) age 18 to 65 years, and 2) able to understand the meaning of the study and to complete a questionnaire without help. Exclusion criteria were 1) pregnancy, 2) inability to stand upright, 3) inability to give sick leave information, or 4) signs of serious spinal pathology. This led to a primary sample size of N = 1071 participants. To ensure homogeneity and avoid bias, only participants were included, who at the time of study had an actual job position and answered all relevant questions needed for SES operationalisation. This reduced the sample size to N=654. Furthermore, because prediction of LBP was the focus of this study, participants already reporting serious chronic pain syndromes at baseline were excluded. This led to a sample of N = 367 participants. Finally, since numbers in the groups of primary educated and lower secondary educated people, agricultural workers, machine operators and elementary occupations was very small (under 10 people in each group), these groups were excluded from further analysis, leading to a final sample size of *N*=352.

Testing procedure: All measurements were performed in four Medicine in Spine Network medical clinics. Participants completed questionnaires regarding SES and LBP at baseline and again 6 months later. Written consent was granted by all participants. The study was approved by the University of Potsdam ethics committee (Ethics approval 36/2011) and is in accordance with the principles of the Declaration of Helsinki.

Instruments and data pre-processing:

<u>SES indicators</u>: Socioeconomic status was evaluated at baseline using the following instruments:

Education was assessed using the International Standard Classification of Education (ISCED), which combines school and vocational education [22], resulting in a score from 0 (less than primary education) to 5 (tertiary education).

Job position was measured using the ten major categories from the International Standard Classification of Occupation (ISCO-08), combining jobs according to main tasks, skill level and specialisation [23].

Monthly net personal income was surveyed using 7 categories (less than 1,250€, 1,250€ to 1,749€, 1,750€ to 2,249€, 2,250€ to 2,999€, 3,000€ to 3,999€, 4,000€ to 4,999€, 5,000€ and more) based on the recommendations of the German Federal Statistical Institute and grouped at the extremes [24].

Multidimensional SES index was calculated using the Winkler-Scheuch-Index (WS-index). This index, a revised version of the German Working Group for Social Epidemiology recommendations [25], is based on three dimensions: education (generated as combination of general and job specific educational level), job position and income. The composition is similar to those of international additive indices. For example Hollighead's "Index of Social Status" [26]. Participants are scored between 1 and 7 for each of the single indicators. The total of these three values then determines the participant's WS-index score [25].

<u>Pain indicators:</u>

Pain intensity was evaluated using the Chronic Pain Grade questionnaire (CPG) created by von Korff [27], which asks about the current intensity of pain, the average intensity of pain in the last three months and the worst experienced pain in the last three months. Possible answers range from 0 (no pain) to 10 (worst pain possible). The mean of these three questions was calculated and multiplied by 10, resulting in a score of 0 to 100 for each participant. These variables were collected at baseline and follow-up 6 months later. Internal consistency was good for both measurement points (baseline: *Cronbach's* α = 0.76; follow-up: *Cronbach's* α = 0.82).

Pain disability was evaluated using three questions from the CPG questionnaire concerning how much pain interfered with daily activities, recreational and social activities and with work (again rated on a scale from 0 to 10). The mean of these three questions was calculated and the result multiplied by 10, resulting in a score from 0 to 100 [27]. Internal consistency was excellent (baseline: *Cronbach's* α = 0.87; follow-up: *Cronbach's* α = 0.93).

Pain Class: To exclude participants with current strong or disabling LBP, a pain classification index was used at baseline (CPG pain classes). This scale grades pain intensity, pain disability and the number of days with limitations due to of pain into 5 classes: 0: no pain; 1: pain with low intensity and low disability; 2: low disability, but high intensity; 3: high disability with few days of limitation in everyday life; 4: high disability with severe limitation in everyday life [27]. For the present study, only participants from pain classes 0 and 1 at baseline were included.

<u>Statistical analysis:</u> After descriptive statistics, four separate hierarchical regression analyses were conducted for each pain outcome using either education, job position, monthly personal net income or the multidimensional index as the respective predictors, while controlling for age and sex, two variables known for their high predictive value in the development of back pain [28]. Education, job position and income thereby were treated as dummy variables to reflect the categorical character of these variables. As most studies only use single indicators to represent SES, a separate model for each indicator was used here as this allowed for demonstration of how much the association between the different indicators and LBP may vary if the other indicators were not taken into account. Requirements of the regression analysis were tested with collinearity diagnosis, Durbin-Watson test and Kolmogorov Smirnoff test for normality of residuals. All analyses were performed with IBM SPSS Statistics 21.

RESULTS

Descriptive statistics: Sample characteristics (Tables 1 and 2) revealed that 55% of respondents were women and on average middle-aged, but ranged from 19 to 65 years. Generally, participants were highly educated, with few people with primary or lower secondary education and held high job positions. The mean monthly net personal income of the sample was between 1,750 and 2,249€ and the average WS-index was 14.9, on the scale from 3 to 21. Pain intensity and disability were both low at baseline and 6-month follow-up. People with primary or lower secondary education, agricultural workers, machine operators and elementary job positions are excluded for further analysis because of the small sample size in the groups.

Table 1: Characteristics of study sample, categorical variables, N = 367:

Variable	N	%		N	%
EDUCATION			**JOB POSITION**		
Primary education	4	1.1	Managers	34	9.2
Lower secondary education	4	1.1	Professionals	97	26.4
Upper secondary education	105	28.5	Technicians	124	34.0
Post-secondary-non tertiary education	80	21.7	Clerical Support Workers	37	10.1
Tertiary education	174	47.6	Service and Sales Workers	50	13.6
INCOME			Agricultural Workers	1	0.3
Under 1250	60	16.3	Craft Workers	16	4.3
1250-1749	74	20.4	Machine Operators	3	0.8
1750-2249	59	16.0	Elementary Occupations	5	1.4
2250-2999	56	15.2			
3000-3999	65	17.7			
4000-4999	28	7.6			
More than 5000	25	6.8			

Table 2: Characteristics of study sample, continuous variables, N = 367:

Variable (Range)	M	SD	Min.	Max.
Age (18 to 65)	41.0	11.8	19	65
Winkler-Scheuch Index (3 to 21)	14.9	2.9	8.2	20.4
CPG pain intensity baseline (0 to 100)	21.0	13.8	0	47
CPG pain intensity follow up (0 to 100)	19.4	16.7	0	67
CPG disability baseline 0 to 100)	9.9	12.7	0	63
CPG disability follow up (0 to 100)	9.7	15.6	0	90
CPG pain class baseline	0.9	0.3	0	1

Regression models:

Regarding the prediction models for pain intensity (Table 3), only ‘job position’ and ‘WS-index’ significantly improved variance explanation. Comparing variance explanation of the respective SES indicators, the ranking was as follows: job position (change in R^2 = 0.04, p < 0.01), WS-index (change in R^2 = 0.02, p < 0.05), education (change in R^2 = 0.02, n.s.) and income (change in R^2 = 0.01, n.s.). In detail, the analysis revealed that people with upper secondary education experience, on average, greater pain intensity compared to people with tertiary education. Considering job position, technicians had significantly lower pain intensity scores compared to managers. Again, no other significant differences were observed. Income did not contribute to variance explanation, nor were there any significant differences between income groups. The multidimensional WS-index (included as a continuous variable) improved the model significantly: People with higher overall SES experienced less back pain.

Table 3: Four different hierarchical regression models predicting influence of different operationalisations of SES on CPG pain intensity score (higher values more pain), controlled for age and sex (*N*=352) ΔR^2 indicates model improvement after application of SES indicator:

Model	ΔR^2	Variable	B	SE B	Beta	p
Model 1: Education Reference group: Tertiary Education	0.01	Upper Secondary Education	4.3	2.0	0.12	0.03*
		Post-secondary non-tertiary education	0.76	2.2	0.02	0.73
Model 2 job position reference group: Manager	0.04**	Professionals	-3.6	2.0	-0.1	0.13
		Technicians	-4.5	2.2	-0.14	0.05*
		Clerical Support Workers	-0.36	3.2	-0.01	0.91
		Service and Sales Workers	2.8	2.7	0.06	0.30
		Craft Workers	8.5	4.5	0.11	0.06
Model 3: Income Reference group: more than 5000€	0.02	Under 1250	5.2	4.2	0.12	0.22
		1250-1749	1.9	3.9	0.05	0.63
		1750-2249	2.1	4.0	0.05	0.61
		2250-2999	5.9	3.9	0.14	0.14
		3000-3999	0.8	3.9	0.02	0.83
		4000-4999	5.0	4.5	0.09	0.27
Model 4: WS-Index	0.02*		-0.9	0.3	-0.15	<0.01*

$*p < 0.05$; $**p < 0.01$

The pain disability models yielded different results (Table 4). Education, job position and WS-index explained a significant amount of variance. Moreover, they had a greater impact in comparison to their impact on pain intensity. The strongest predictor was job position (change in R^2=0.07, p<0.01), followed by WS-index (change in R^2=0.05, p<0.01) then education (change in R^2=0.02, p<0.05). Income had no significant influence. Further, people with professional, secondary education were significantly more disabled because of back pain compared to people with tertiary education. Professionals experienced, in comparison with managers, significant lower impairment, while craft workers experienced significantly more. Although the income model did not improve variance explanation, people with an income of less than 1,250€ experienced significantly more impairment than people with an income over 5000€. In general, people with a higher SES experienced fewer limitations due to their back pain.

Table 4: Four hierarchical regression models predicting influence of different operationalisations of SES on CPG pain disability score (higher values more pain), controlled for age and sex (N = 352). ΔR^2 indicates model improvement after application of SES indicator:

Model	ΔR²	Variable	B	SE B	Beta	p
Model 1: Education Reference group: Tertiary Education	0.02*	Upper Secondary Education	5.8	2.0	0.17	<0.01**
		Post-secondary non-tertiary education	2.6	2.2	0.07	0.22
Model 2 job position reference group: Manager	0.07**	Professionals	-5.2	2.0	-0.16	<0.01**
		Technicians	-1.9	2.2	-0.06	0.38
		Clerical Support Workers	0.8	3.1	0.02	0.80
		Service and Sales Workers	2,4	2.7	0.05	0.36
		Craft Workers	13.1	4.4	0.17	<0.01**
Model 3: Income Reference group: more than 5000€	0.02	Under 1250	8.8	4.1	0.20	0.03*
		1250-1749	4.9	3.9	0.13	0.21
		1750-2249	4.9	4.0	0.12	0.21
		2250-2999	4.5	3.9	0.10	0.25
		3000-3999	1.3	3.9	0.03	0.73
		4000-4999	2.5	4.4	0.04	0.57
Model 4: WS-Index	0.05**		-1.3	0.3	-0.23	<0.01**

*$p < 0.05$; **$p < 0.01$

DISCUSSION

The purpose of this study was to investigate the associations between common SES indicators and intermitted LBP in a single sample and observe changes in association as a function of SES indicator. Differences were indeed found in the predictive power of commonly used SES indicators, which means SES predictors should be carefully selected in order not to underestimate the SES influence on LBP. Based on these results, it appears that job position is the most appropriate SES indicator for studies regarding intermitted LBP. In general however, only income and education for pain intensity could be identified as suboptimal predictor. In this respect, the current findings differ from studies in other health domains comparing the relative impact of SES predictors. For example, Geyer and colleagues [6] found education to be a much stronger predictor for diabetes than job position and income to predict better overall mortality compared to education and job position. Whereas, Miech and colleagues [8] determined education to more strongly predict subjective health than occupation. This was not confirmed by Geyer [9], who found income and job position to have a greater influence on subjective health than education. This emphasizes the importance of rethinking the possible pathways connecting SES indicators and each distinct health outcome in question.

With regard to the hypothesized associations the findings are only partly in line. We hypothesized that the multidimensional index and job position, followed by education would be the most influential predictors of pain intensity, whereas income we believed would play little or no role. As predicted, job position was found to be the strongest indicator: In detail, technicians (and tendentially professionals) showed significantly less pain intensity. One reason for this may include that technicians have better awareness and opportunities to adjust or tend to their LBP by reducing work stress, for example. Income, as suggested, showed no significant influence and was not able to predict pain intensity. Education in general did not contribute to variance explanation, although people with upper secondary education did experience significantly more pain than people with tertiary education. We believe, because educated people should have better knowledge, thus judgement to choose adequate (health) behaviours when confronted with pain [5], their pain is reduced.

Finally, *a priori,* it was assumed the WS-index, combining the influences of the single indicators would have significantly more predictive power. This was not the case in the present study though. It appears the addition of single SES dimensions do not necessarily yield a cumulative increase in predictive power, something Geyer [9] previously showed in a different health domain. The overlapping of indicators and mediating factors could be the problem here, leading to a shared influence on back pain for all indicators, or the effect of one indicator being counterbalanced by another.

Reviewing SES and pain disability associations, results are again only partially in line with our hypotheses. First, job position was, as expected, the most influential single predictor. Professionals experienced significantly less impairment due to their LBP, while craft workers experienced more. As with pain intensity, we believe professionals have better possibilities to adjust in their work places when experiencing LBP, so that they are not as hampered compared to managers or craft workers.

The multidimensional index explained the second most variance. Again, it seems wrong to assume that the impact of single dimensions will simply add up, making multidimensional indices more influential than single indicators. With regard to education, the results agreed with our assumptions. Education predicted pain disability, but not as well as job position or WS-index. Again, upper secondary educated people experienced stronger impairment than tertiary educated people. Reasons for this may lie in the educated people knowing better how to adjust their everyday life as not avoid their pain.

Income in general explained no significant part of pain disability variance, although people in the lowest income class reported greater impairment in comparison with those from the highest. Better incomes may enable these people to acquire material resources, which reduce their disability in everyday life.

To our knowledge this is the first study to compare the predictive strength of various SES indicators on intermitted LBP in a single sample, thereby adding to the literature that advocates a critical and careful selection of SES indicators. While the results of this and other studies suggest SES indicators should be selected carefully and should not be used interchangeably, it has proven difficult to predict *a priori*, which SES indicator will be most appropriate. In this study, the pathways described in the model of Brunner and Marmot [15] was used to predict the association between various SES indicators and intermitted LBP, though findings were not fully in line with these predictions.

The results presented in this paper are afflicted by some limitations, namely the small group sizes of primary and lower secondary educated people, agricultural workers, machine operators and elementary occupations, leading to the exclusion of these groups. A repetition of the research design with a larger sample would make the results more reliable. Furthermore, the study was conducted in four study centres in different federal states of Germany. Although Germany has comparable numbers to other European countries regarding prevalence and severity rates of pain [29], country specific differences may lead to other results in other countries. Additionally, not all approaches of gauging SES were taken into account. Newer approaches, for example self-assessed socioeconomic status [30, 31] or neighbourhood indicators [3], could improve future studies, but as of yet, no statement can be made as to whether these approaches would have influenced results.

Nonetheless, this study showed especially job position as an important dimension concerning SES influence on intermittent LBP. Further research aiming to prevent and reduce intermittent LBP should therefore focus on conditions that may be influenced by job positions.

AUTHOR CONTRIBUTION

All authors substantially contributed to the conception and realization of this article. MF conceived and wrote the first draft of this manuscript and provided statistical analysis. JW and PW revised the manuscript. PW was responsible for the psychometric design, analysis plan and conceived the social methods of the multicentre study. All authors read and approved the final manuscript.

COMPETING INTERESTS:

The authors declare that they have no competing interests.

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ETHICAL APPROVAL

The study was approved by the independent ethics committee of University of Potsdam (Ethics approval 36/2011).

DATA SHARING:

No additional data available

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REFERENCES

1 Braveman PA, Cubbin C, Egerter S, et al. Socioeconomic Status in Health: One Size Does Not Fit All. *JAMA* 2005;294(22):2879–88.

2 Nocon M, Keil T, Willich SN. Education, income, occupational status and health risk behaviour. *J Public Health* 2007;15(5):401–05.

3 Fliesser M, Klipker K, Wippert P-M. Zur Verwendung des soziookonomischen Status in der Gesundheitsforschung am Beispiel Ruckenschmerz - systematisches Review. *Gesundheitswesen* 2016.

4 Cundiff JM, Uchino BN, Smith TW, et al. Socioeconomic status and health: education and income are independent and joint predictors of ambulatory blood pressure. *J Behav Med* 2015;38(1):9–16.

5 Hradil S. Was prägt das Krankheitsrisiko- Schicht, Lage, Lebensstil? In: Richter M, Hurrelmann K, eds. Gesundheitliche Ungleichheit: Grundlagen, Probleme, Perspektiven, 2nd edn. Wiesbaden: VS, Verl. für Sozialwiss 2009:33–52.

6 Geyer S, Hemström O, Peter R, et al. Education, income, and occupational class cannot be used interchangeably in social epidemiology. Empirical evidence against a common practice. *J Epidemiol Community Health* 2006;60(9):804–10.

7 Stringhini S, Dugravot A, Kivimaki M, et al. Do different measures of early life socioeconomic circumstances predict adult mortality? Evidence from the British Whitehall II and French GAZEL studies. *J Epidemiol Community Health* 2011;65(12):1097–103.

8 Miech RA, Hauser RM. Socioeconomic Status and Health at Midlife: A Comparison of Educational Attainment with Occupation-Based Indicators. *Annals of Epidemiology* 2001;11(2):75–84.

9 Geyer S. Einzelindikator oder Index? Masse sozialer Differenzierung im Vergleich. *Gesundheitswesen* 2008;70(5):281–88.

10 Hoy D, Bain C, Williams G, et al. A systematic review of the global prevalence of low back pain. *Arthritis Rheum* 2012;64(6):2028–37.

11 van Hecke O, Torrance N, Smith BH. Chronic pain epidemiology - where do lifestyle factors fit in? *Br J Pain* 2013;7(4):209–17.

12 Goldberg DS, McGee SJ. Pain as a global public health priority. *BMC Public Health* 2011;11:770.

13 van Hecke O, Torrance N, Smith BH. Chronic pain epidemiology and its clinical relevance. *Br J Anaesth* 2013;111(1):13–18.

14 Latza U, Kohlmann T, Deck R, et al. Influence of Occupational Factors on the Relation Between Socioeconomic Status and Self-Reported Back Pain in a Population-Based Sample of German Adults With Back Pain. *Spine* 2000;25(11):1390–97.

15 Brunner G, Marmot MG. Social organisation, stress, and health. In: Marmot MG, Wilkinson RG, eds. Social determinants of health, 2nd edn. Oxford, New York: Oxford University Press 2011:6–30.

16 Bair MJ, Robinson RL, Katon W, et al. Depression and pain comorbidity: A literature review. *Arch Intern Med* 2003;163(20):2433–45.

17 Hoy D, Brooks P, Blyth F, et al. The Epidemiology of low back pain. *Best Pract Res Clin Rheumatol* 2010;24(6):769–81.

18 Chou R, Shekelle P. Will this patient develop persistent disabling low back pain? *JAMA* 2010;303(13):1295–302.

19 Brox JI, Storheim K, Holm I, et al. Disability, pain, psychological factors and physical performance in healthy controls, patients with sub-acute and chronic low back pain: a case-control study. *J Rehabil Med* 2005;37(2):95–99.

20 Melloh M, Elfering A, Egli Presland C, et al. Identification of prognostic factors for chronicity in patients with low back pain: a review of screening instruments. *Int Orthop* 2009;33(2):301–13.
21 Wippert P-M, Puschmann A-K, Drießlein D, et al. Development of a Risk Stratification Index and a Risk Prevention Index for chronic low back pain in primary care. Focus: yellow flags (MiSpEx Network). *PAIN-Reports* pub. ahead.
22 UNESCO. International standard classification of education: ISCED 2011. Montreal, Quebec: UNESCO Institute for Statistics 2012.
23 Statistik Austria. ISCO 08- gemeinsame deutschsprachige Titel und Erläuterungen 2011. Available at: http://www.statistik.at/wcm/idc/idcplg?IdcService=GET_PDF_FILE&dDocName=049974.
24 Destatis. Demografische Standards 2017. Available at: https://www.destatis.de/DE/Methoden/DemografischeRegionaleStandards/DemografischeStandardsInfo.html.
25 Lampert T, Kroll LE, Müters S, et al. Messung des sozioökonomischen Status in der Studie "Gesundheit in Deutschland aktuell" (GEDA). *Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz* 2013;56(1):131–43. 23275948.
26 Hollinghead AB. Four Factor Index of Social Status. *Yale Journal of Sociology* 2011;8:21–52.
27 Korff M, Ormel J, Keefe FJ, et al. Grading the severity of chronic pain. *Pain* 1992;50(2):133–49.
28 Schepper EIT de, Damen J, van Meurs JBJ, et al. The association between lumbar disc degeneration and low back pain: The influence of age, gender, and individual radiographic features. *Spine* 2010;35(5):531–36.
29 Breivik H, Collett B, Ventafridda V, et al. Survey of chronic pain in Europe: prevalence, impact on daily life, and treatment. *European Journal of Pain* 2006;10(4):287–333.
30 Präg P, Mills MC, Wittek R. Subjective socioeconomic status and health in cross-national comparison. *Soc Sci Med* 2016;149:84–92.
31 Hoebel J, Müters S, Kuntz B, et al. Messung des subjektiven sozialen Status in der Gesundheitsforschung mit einer deutschen Version der MacArthur Scale. *Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz* 2015;58(7):749–57 (accessed 28 Aug 2015).

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract Check Page 1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found Check Page 2
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported Check Pages 3 and 4
Objectives	3	State specific objectives, including any prespecified hypotheses Check Page 4
Methods		
Study design	4	Present key elements of study design early in the paper Check Title and Pages 4, 5, 6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection Check Pages 4 and 5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants Check Pages 4 and 5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable Check Pages 5 and 6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group Check Pages 5 and 6
Bias	9	Describe any efforts to address potential sources of bias Check Page 6
Study size	10	Explain how the study size was arrived at Check Page 4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why Check Page 6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding Check Page 6
		(*b*) Describe any methods used to examine subgroups and interactions Not applicable
		(*c*) Explain how missing data were addressed Check Page 4
		(*d*) If applicable, describe analytical methods taking account of sampling strategy Not applicable
		(*e*) Describe any sensitivity analyses Not applicable
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed Check Pages 4 and 5
		(b) Give reasons for non-participation at each stage Check Pages 4 and 5
		(c) Consider use of a flow diagram Not used
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders Check Pages 6 and 7
		(b) Indicate number of participants with missing data for each variable of interest Not applicable (all participants with missing data were excluded)
Outcome data	15*	Report numbers of outcome events or summary measures Check Table 2
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included Check Tables 3 and 4

		(*b*) Report category boundaries when continuous variables were categorized Check Table1
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period Not relevant
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses Not applicable
Discussion		
Key results	18	Summarise key results with reference to study objectives Check Page 9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias Check Page 11
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence Check Page 12
Generalisability	21	Discuss the generalisability (external validity) of the study results Check Page 11
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based Check Page 13

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Education, job position, income or multidimensional indices? Associations between different socioeconomic status indicators and chronic low back pain in a German sample: a longitudinal field study

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Education, job position, income or multidimensional indices? Associations between different socioeconomic status indicators and chronic low back pain in a German sample: a longitudinal field study

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ABSTRACT:

Objective: To investigate associations between socioeconomic status indicators (education, job position, income, multidimensional index) and the genesis of chronic low back pain (CLBP).

Design: Longitudinal field study (baseline and 6-month follow-up)

Setting: Four medical clinics across Germany

Participants: 352 people were included according to the following criteria: 1) between 18 and 65 years of age, 2) intermittent pain, and 3) an understanding of the study and the ability to answer a questionnaire without help. Exclusion criteria were: 1) pregnancy, 2) inability to stand upright, 3) inability to give sick leave information, 4) signs of serious spinal pathology, 5) acute pain in the past 7 days, or 6) an incomplete SES indicators questionnaire.

Outcome measures: subjective intensity and disability of CLBP

Results: Analysis showed that job position was the best single predictor of CLBP intensity, followed by a multidimensional index. Education and income had no significant association with intensity. Subjective disability was best predicted by job position, succeeded by the multidimensional index and education, while income again had no significant association.

Conclusion: The results showed that SES indicators have different strong associations with the genesis of CLBP and should therefore not be used interchangeably. Job position was found to be the single most important indicator. These results could be helpful in the planning of back pain care programs, but in general, more research on the relationship between SES and health outcomes is needed.

STRENGTHS AND LIMITATIONS OF THIS STUDY:

- Analysis of different SES indicators and their influence on the genesis of chronic low back pain.
- This comparison was driven by various regression models within the same sample to highlight variations in CLBP prediction when using different SES indicators.
- Limitations include a small and homogeneous sample of above average SES status and the use of only the most common SES indicators, the setting in one country and the focus on one health domain.
- Transferability has to be proven in other health settings and countries.

BACKGROUND

In the health sciences, it is widely accepted that socioeconomic status (SES) is linked to many health outcomes [1]. However, less is known about the causal pathways and mediating factors that lead to these outcomes. This gap in research is partially caused by unresolved methodological issues concerning the operationalization of SES. Because SES is a latent construct, various indicators can be used to measure a person's SES. The most commonly used indicators are education, job position and income, or combinations of these variables [2]. The justification for specific SES indicator use is often not adequately described in articles [3], and some SES indicators are even used interchangeably [4]. This limits the interpretation of results because different indicators are based on different theoretical models connecting SES-indicators to health outcomes. For example, job position is strongly connected with stress, which then detrimentally influences health. Whereas, education is strongly associated with knowledge about health and treatments [5]. It thus becomes obvious that the chosen indicator will indeed influence the association with specific health outcomes. This has already been confirmed for several health outcomes, including myocardial infarction [6], overall mortality [6, 7], diabetes [6] and subjective health status [8, 9]. After reviewing these studies, two things become noteworthy. First, each SES indicator differs in its connection with specific health outcomes, which leads to the notion that SES indicators should initially be analysed separately for each health domain of interest. Secondly, in the studies investigating links between SES and health outcomes, it was rarely acknowledged that different indicators led to different results, nor discussed why [3]. For a better understanding of the relationship between SES and health improved methodology yielding more information concerning indicator associations and underlying mechanisms, is needed. Therefore, the objective of this study was to compare and report the association of common SES indicators with the genesis of one common global health problem, chronic low back pain (CLBP).

CLBP seems a suitable health outcome to investigate regarding its connection to SES It is a major public health burden with an international lifetime prevalence of approximately 39 %, whereby about 20% of people suffer from CLBP [10]. Moreover, the development of chronic pain has a multidimensional aetiology and is moderated by health behaviour [11], as well as social [12] and psychological factors [13]. For these reasons, we hypothesize that different SES indicators will lead to different degrees of association in the genesis of CBLP. However, past studies analysing CLBP and SES have used a variety of different SES indicators, often without explanation [3]. To date, only one study from Latza et al. has compared different SES indicators and their relative influence on self-reported back pain. They found education to have the strongest association with chronic back pain, followed by job position and income [14]. However, and this is crucial, they did not use identical samples for all SES prediction calculations. So it is not clear whether the observed differences were caused by the

SES indicators or by differences in the samples. Hence, a study investigating the link between different SES indicators and CLBP in a single sample is needed.

Before evaluating, it is important to have a differentiated perspective on factors mediating the relationship between SES and health [5]. According to the well-established model of social determinants of health by Brunner and Marmot [15], there are three groups of factors mediating SES and health: material factors (e.g. pollution), social and psychological factors (e.g. stress) and health behaviour (e.g. dietary habits). Translating this general model to the current example, prior research has revealed that CLBP is most strongly associated with social and psychological factors, such as depressive symptoms [16], stress [17] and dissatisfaction with work organisation [18]. Health behaviour has also been associated with CLBP [19, 20], however, material factors have not. Based on these findings, it could be assumed that SES indicators more closely associated with social/psychological factors and health behaviour will have stronger associations with CLBP. Hradil et al., examining the influence of SES indicators on cardiovascular diseases, assumed job position to be most strongly connected with social and psychological factors, education with health behaviour and income with material factors [5]. Using these assumptions, we hypothesise that the single indicator, job position will be strongly associated with the genesis of CLBP, followed by education. Income, we believe, will have the weakest association. The multidimensional index, covering all possible pathways, should however yield the strongest association.

METHOD

Sample: Participants were recruited from four medical clinics across Germany as part of a national study on LBP (National Research Network for Medicine in Spine Exercise, MiSpEx, [21]). Inclusion criteria consisted of: 1) 18 to 65 years of age, 2) intermittent pain, 3) an understanding of the study and the ability to answer a questionnaire without help. Exclusion criteria were 1) pregnancy, 2) inability to stand upright, 3) inability to give sick leave information, or 4) signs of serious spinal pathology. This led to a primary sample size of N = 1071 participants. To ensure homogeneity and to avoid bias, only participants, who at the time of assessment were actually employed and answered all relevant SES indicator questions, were included. This reduced the sample size to N = 654. Furthermore, as SES association with the genesis of CLBP is the focus, participants already reporting serious chronic pain syndromes at baseline were excluded, reducing the sample to N = 367 participants. After final screening, an insufficient number of some SES groups (primary and lower-secondary educational level, agricultural workers, machine operators and elementary occupations) was observed (under 10 people in each group), therefore these groups were excluded from further analysis, leading to a final sample size of N = 352.

Testing procedure: All measurements were performed in the four medical clinics of the MiSpEx Network. Participants completed questionnaires regarding SES and CLBP at baseline and again six months later. Written consent was obtained from all participants. The study was approved by the University of Potsdam ethics committee (Ethics approval 36/2011) and is in accordance with the principles of the Declaration of Helsinki.

Patient and Public Involvement: Participants were informed, that the study is about LBP. They were not involved in the development of the design, recruitment, or study conduction. Each participant got an individual feedback of his or her results shortly after the study was finished**.**

Instruments and data pre-processing:

SES indicators: Socioeconomic status was evaluated at baseline using the following instruments:

Education was assessed using the International Standard Classification of Education (ISCED), which combines school and vocational education [22], resulting in a score from 0 (less than primary education) to 5 (tertiary education).

Job position was measured using the ten major categories from the International Standard Classification of Occupation (ISCO-08), combining jobs according to main tasks, skill level and specialisation [23].

Monthly net personal income was separated into 7 brackets (less than 1,250€, 1,250€ to 1,749€, 1,750€ to 2,249€, 2,250€ to 2,999€, 3,000€ to 3,999€, 4,000€ to 4,999€, 5,000€ and more) based on the recommendations of the German Federal Statistical Institute and grouped at the extremes [24].

Multidimensional SES index was calculated using the Winkler-Scheuch-Index (WS-index). This index, a revised version of the German Working Group for Social Epidemiology recommendations [25], is based on three dimensions: education (a combination of general and job specific educational level obtained together with ISCED), job position (a combination of position and qualification) and income. The composition is similar to those of international additive indices, for example, Hollighead's "Index of Social Status" [26]. Participants were scored between 1 and 7 for each of the single indicators. The total of these three values then determined the participant's WS-index score [25].

Pain indicators:

Pain intensity was evaluated using the Chronic Pain Grade questionnaire (CPG) created by von Korff [27], which inquires the current intensity of pain, the average intensity of pain in the last three months and the worst experienced pain in the last three months. Possible answers range from 0 (no pain) to 10 (worst pain possible). The mean of these three questions was calculated and multiplied by 10, resulting in a score of 0 to 100 for each participant. These variables were collected at baseline and follow-up 6 months later. Internal consistency was good at both measurement points (baseline: *Cronbach's* α = 0.76; follow-up: *Cronbach's* α = 0.82).

Pain disability was evaluated using three questions from the CPG questionnaire concerning how much pain interfered with daily, recreational, social and work activities (again rated on a scale from 0 to 10). The mean of these three questions was calculated and the result multiplied by 10, resulting in a score from 0 to 100 [27]. Internal consistency was excellent at both measurement points (baseline: *Cronbach's α* = 0.87; follow-up: *Cronbach's α* = 0.93).

Pain Class: To exclude participants with current strong or disabling CLBP, a pain classification index was used at baseline (CPG pain classes). This scale grades pain intensity, pain disability and the number of days with limitations due to pain into 5 classes: 0) no pain, 1) pain with low intensity and low disability, 2) pain with low disability, but high intensity, 3) pain with high disability with few days of limitation in everyday life, 4) pain with high disability with severe limitation in everyday life [27]. For the present study, only participants from pain classes 0 and 1 at baseline were included.

Statistical analysis: After descriptive statistics calculation, four separate hierarchical regression analyses were conducted for each pain outcome using either education, job position, monthly personal net income or the multidimensional index as the respective predictors, while controlling for age and sex. These two variables are known for their high predictive value in the development of back pain [28]. Education, job position and income thereby were treated as dummy variables to reflect the categorical character of these variables. As most studies only use one indicator to represent SES, a separate model for each indicator was used here as this allowed for comparisons in variability if the other indicators had not been taken into account. Requirements of the regression analysis were tested with collinearity diagnosis, Durbin-Watson test and Kolmogorov Smirnoff test for normality of residuals. All analyses were performed with IBM SPSS Statistics 21.

RESULTS

Descriptive statistics: Sample characteristics (Tables 1 and 2) revealed 55% of respondents were women and on average the sample was middle-aged, but ranging from 19 to 65 years. Generally, participants were highly educated and held high job positions. Mean monthly net personal income was between 1,750 and 2,249€, while the average WS-index score was 14.9 on the scale from 3 to 21. CLBP intensity and disability were low at both baseline and 6-month follow-up.

People with primary or lower secondary education, agricultural workers, machine operators and elementary job positions are excluded for further analysis because of the small sample size in the groups.

Table 1: Sample characteristics. (Categorical variables, *N* = 367)

Variable	N	%		N	%
EDUCATION			**JOB POSITION**		
Primary education	4	1.1	**Managers**	34	9.2
Lower secondary education	4	1.1	**Professionals**	97	26.4
Upper secondary education	105	28.5	**Technicians**	124	34.0
Post-secondary-non tertiary education	80	21.7	**Clerical Support Workers**	37	10.1
Tertiary education	174	47.6	**Service and Sales Workers**	50	13.6
INCOME			**Agricultural Workers**	1	0.3
Under 1250€	60	16.3	**Craft Workers**	16	4.3
1250-1749€	74	20.4	**Machine Operators**	3	0.8
1750-2249€	59	16.0	**Elementary Occupations**	5	1.4
2250-2999€	56	15.2			
3000-3999€	65	17.7			
4000-4999€	28	7.6			
More than 5000€	25	6.8			

Table 2: Sample characteristics. (Continuous variables, *N* = 367)

Variable (Range)	M	SD	Min.	Max.
Age (18 to 65)	41.0	11.8	19	65
Winkler-Scheuch Index (3 to 21)	14.9	2.9	8.2	20.4
CPG pain intensity baseline (0 to 100)	21.0	13.8	0	47
CPG pain intensity follow up (0 to 100)	19.4	16.7	0	67
CPG disability baseline 0 to 100)	9.9	12.7	0	63
CPG disability follow up (0 to 100)	9.7	15.6	0	90
CPG pain class baseline	0.9	0.3	0	1

Regression models:

Regarding pain intensity (Table 3), only ‘job position’ and ‘WS-index’ significantly improved variance explanation. Comparing variance explanation of respective SES indicators, the ranking was as follows: job position (change in R^2 = 0.04, p < 0.01), WS-index (change in R^2 = 0.02, p < 0.05), education (change in R^2 = 0.02, n.s.) and income (change in R^2 = 0.01, n.s.). Further, analysis revealed that people with upper secondary education reported, on average, greater pain intensity compared to people with tertiary education. Considering job position, technicians had significantly lower pain intensity scores compared to managers. Income did not contribute to variance explanation, nor were there any significant differences between income brackets. The multidimensional WS-index (included as a continuous variable) improved the model significantly to confirm people with higher overall SES reported less back pain.

Table 3: Four hierarchical regression models of different operationalisations predicting influence of SES on CPG pain intensity score (higher values more pain). Controlled for age and sex (N = 352). ΔR^2 indicates model improvement after application of SES indicator.

Model	ΔR²	Variable	B	SE B	p
Model 1: Education	0.01	Upper Secondary Education (Reference: tertiary education)	4.3	2.0	0.03*
		Post-secondary non-tertiary education (Reference: tertiary education)	0.76	2.2	0.73
Model 2: Job position	0.04**	Professionals (Reference: managers)	-3.6	2.0	0.13
		Technicians (Reference: managers)	-4.5	2.2	0.05*
		Clerical Support Workers (Reference: managers)	-0.36	3.2	0.91
		Service and Sales Workers (Reference: managers)	2.8	2.7	0.30
		Craft Workers (Reference: managers)	8.5	4.5	0.06
Model 3: Income	0.02	Under 1250€ (Reference: more than 5000€)	5.2	4.2	0.22
		1250-1749€ (Reference: more than 5000€)	1.9	3.9	0.63
		1750-2249€ (Reference: more than 5000€)	2.1	4.0	0.61

		2250-2999€ (Reference: more than 5000€)	5.9	3.9	0.14
		3000-3999€ (Reference: more than 5000€)	0.8	3.9	0.83
		4000-4999€ (Reference: more than 5000€)	5.0	4.5	0.27
Model 4: WS-Index	0.02*		-0.9	0.3	<0.01*

*$p < 0.05$; **$p < 0.01$

Pain disability models yielded different results (Table 4). Education, job position and WS-index explained a significant amount of variance, even sharing a stronger association in comparison to pain intensity. The strongest predictor was job position (change in R^2 = 0.07, $p < 0.01$), followed by WS-index (change in R^2 = 0.05, $p < 0.01$), then education (change in R^2 = 0.02, $p < 0.05$). Income had no significant association with disability. People with professional, secondary education were significantly more disabled due to back pain than people with tertiary education. Professionals reported, in comparison with managers, significantly less impairment, while craft workers reported significantly more. Although the income model did not improve variance explanation, people with an income of less than 1,250€ reported significantly more impairment than people earning over 5000€. People with a higher general SES (indicated by the multidimensional index) reported fewer limitations due to back pain.

Table 4: Four hierarchical regression models of different operationalisations predicting influence of SES on CPG pain disability score. Controlled for age and sex (N = 352). ΔR^2 indicates model improvement after application of SES indicator.

Model	ΔR^2	Variable	B	SE B	p
Model 1: Education	0.02*	Upper Secondary Education (Reference: tertiary education)	5.8	2.0	<0.01**
		Post-secondary non-tertiary education (Reference: tertiary education)	2.6	2.2	0.22
Model 2: Job position	0.07**	Professionals (Reference: managers)	-5.2	2.0	<0.01**
		Technicians (Reference: managers)	-1.9	2.2	0.38
		Clerical Support Workers	0.8	3.1	0.80

		(Reference: managers)			
		Service and Sales Workers (Reference: managers)	2,4	2.7	0.36
		Craft Workers (Reference: managers)	13.1	4.4	<0.01**
Model 3: Income	0.02	Under 1250€ (Reference: more than 5000€)	8.8	4.1	0.03*
		1250-1749€ (Reference: more than 5000€)	4.9	3.9	0.21
		1750-2249€ (Reference: more than 5000€)	4.9	4.0	0.21
		2250-2999€ (Reference: more than 5000€)	4.5	3.9	0.25
		3000-3999€ (Reference: more than 5000€)	1.3	3.9	0.73
		4000-4999€ (Reference: more than 5000€)	2.5	4.4	0.57
Model 4: WS-Index	0.05**		-1.3	0.3	<0.01**

*$p < 0.05$; **$p < 0.01$

DISCUSSION

The purpose of this study was to report and compare the association of common SES indicators with the genesis of CLBP. Differences between these indicators were found, suggesting that SES indicators should be selected very carefully to avoid underestimation of SES's influence on CLBP. Our results show job position is the strongest predictor and should always be appraised in further research regarding CLBP. In contrast, income and education were determined to be suboptimal predictors of CLBP. In this respect, the current findings differ from studies in other health domains. For example, Geyer et al. [6] found education to be a much stronger predictor of diabetes than job position, and income was a better predictor of overall mortality compared to education and job position. Miech et al. [8] determined education to better predict subjective health than occupation, which was not corroborated by Geyer [9], who found income and job position to be superior. Again, this just illustrates the consequences of SES operationalization and the importance of considering all possible pathways connecting SES indicators and distinct health outcomes.

In line with our hypothesis, we confirmed the single indicator, job position, and the multidimensional index to be the most influential predictors of CLBP intensity. In detail, technicians reported significantly less CLBP intensity compared to managers. We believe this could be due to technicians' greater coping opportunities, but further research should be designed to answer such questions.

Income showed no significant associations and was not a reliable predictor for CLBP intensity. Education, as well, did not explain variance, although people with upper secondary education did experience significantly more pain than people with tertiary education. Previous studies have explained such findings to be influenced by better knowledge concerning healthy and preventative behaviour [5]. We reasonable assumed that the WS-index would yield a significantly stronger association than the single indicators; yet, this was not the case. Clearly, the addition of single SES dimensions does not necessarily deliver a cumulative increase in the association, which was also found to be the case by Geyer et al. [9], albeit in a different health domain. The overlapping of indicators and mediating factors is potentially the problem here, leading to a shared influence on CLBP for all indicators or effects of one indicator being counterbalanced by another.

Focusing on associations between SES and CLBP disability, our results were again partly in agreement with our hypotheses. Job position was, as expected, the most influential single predictor. Professionals reported significantly less impairment due to CLBP compared to managers, while craft workers reported more. In similar vein as the intensity results, we believe professionals have better possibilities to adjust their work environments when experiencing CLBP, something neither managers nor craft workers are afforded. The multidimensional index explained the second most variance in CLBP disability. Again, we found it is wrong to assume the associations of single dimensions will sum up. Education was also a significant predictor of CLBP disability, but not to the degree of job position or WS-index. Similarly, to intensity, upper secondary educated people reported greater impairment compared to tertiary educated people. Income could not significantly explain any variance, although people in the lowest income bracket reported greater impairment in comparison with those from the highest. Higher incomes may enable these people to acquire certain material resources, which could reduce their disability in everyday life.

To our knowledge this is the first study to compare the association of various SES indicators with CLBP in a single sample. Our results confirm SES indicators should be selected carefully and not used interchangeably. In our study, the pathways described in the model of Brunner and Marmot [15] were used to predict associations between various SES indicators and CLBP. Our findings did however contradict some of these predictions emphasizing just how difficult it is to predict *a priori*, the most appropriate SES indicators.

The results presented in this paper are afflicted by some limitations, namely the small group sizes of primary and lower secondary educated people, agricultural workers, machine operators and elementary occupations, which led to the exclusion of these groups. This reduces the explanatory power of the results and may produce an underestimation in the predicted association of education and job position. A replication study including more people from lower education and job groups would assure more conclusive and generalizable results. Furthermore, the lowest income bracket was relatively broad. We speculate income may have had a stronger association, had this category been split up. The study was also conducted in four study centres in Germany. Although Germany has comparable numbers to other European countries regarding pain prevalence and severity rates [29], country specific differences may lead to conflicting results in other countries. Additionally, not all approaches to gauge SES were taken into account. Newer approaches, for example self-assessed socioeconomic status [30, 31] or neighbourhood indicators [3], could improve future studies, but as of yet, no statement can be made as to whether these approaches would have influenced our results. In this study, income was evaluated as personal net income, but perhaps the material situation of some would be better reflected by household income, which may hide some heterogeneity.

In conclusion, this study highlighted job position as an all-important dimension concerning SES's association with CLBP. Further research aiming to prevent and reduce CLBP should therefore focus on conditions that may be influenced by job positions.

AUTHOR CONTRIBUTION

All authors substantially contributed to the conception and realization of this article. MF conceived and wrote the first draft of this manuscript and provided statistical analysis. JW and PW revised the manuscript. PW was responsible for the psychometric design, analysis plan and conceived the social methods of the multicentre study. All authors read and approved the final manuscript.

COMPETING INTERESTS:

The authors declare that they have no competing interests.

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ETHICAL APPROVAL

The study was approved by the independent ethics committee of University of Potsdam (Ethics approval 36/2011).

DATA SHARING:

No additional data available

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REFERENCES

1 Braveman PA, Cubbin C, Egerter S, et al. Socioeconomic Status in Health: One Size Does Not Fit All. *JAMA* 2005;294(22):2879–88.
2 Nocon M, Keil T, Willich SN. Education, income, occupational status and health risk behaviour. *J Public Health* 2007;15(5):401–05.
3 Fliesser M, Klipker K, Wippert P-M. Zur Verwendung des soziookonomischen Status in der Gesundheitsforschung am Beispiel Ruckenschmerz - systematisches Review. *Gesundheitswesen* 2016.
4 Cundiff JM, Uchino BN, Smith TW, et al. Socioeconomic status and health: education and income are independent and joint predictors of ambulatory blood pressure. *J Behav Med* 2015;38(1):9–16.
5 Hradil S. Was prägt das Krankheitsrisiko- Schicht, Lage, Lebensstil? In: Richter M, Hurrelmann K, eds. Gesundheitliche Ungleichheit: Grundlagen, Probleme, Perspektiven, 2nd edn. Wiesbaden: VS, Verl. für Sozialwiss 2009:33–52.
6 Geyer S, Hemström O, Peter R, et al. Education, income, and occupational class cannot be used interchangeably in social epidemiology. Empirical evidence against a common practice. *J Epidemiol Community Health* 2006;60(9):804–10.
7 Stringhini S, Dugravot A, Kivimaki M, et al. Do different measures of early life socioeconomic circumstances predict adult mortality? Evidence from the British Whitehall II and French GAZEL studies. *J Epidemiol Community Health* 2011;65(12):1097–103.
8 Miech RA, Hauser RM. Socioeconomic Status and Health at Midlife: A Comparison of Educational Attainment with Occupation-Based Indicators. *Annals of Epidemiology* 2001;11(2):75–84.
9 Geyer S. Einzelindikator oder Index? Masse sozialer Differenzierung im Vergleich. *Gesundheitswesen* 2008;70(5):281–88.
10 Hoy D, Bain C, Williams G, et al. A systematic review of the global prevalence of low back pain. *Arthritis Rheum* 2012;64(6):2028–37.
11 van Hecke O, Torrance N, Smith BH. Chronic pain epidemiology - where do lifestyle factors fit in? *Br J Pain* 2013;7(4):209–17.
12 Goldberg DS, McGee SJ. Pain as a global public health priority. *BMC Public Health* 2011;11:770.
13 van Hecke O, Torrance N, Smith BH. Chronic pain epidemiology and its clinical relevance. *Br J Anaesth* 2013;111(1):13–18.
14 Latza U, Kohlmann T, Deck R, et al. Influence of Occupational Factors on the Relation Between Socioeconomic Status and Self-Reported Back Pain in a Population-Based Sample of German Adults With Back Pain. *Spine* 2000;25(11):1390–97.
15 Brunner G, Marmot MG. Social organisation, stress, and health. In: Marmot MG, Wilkinson RG, eds. Social determinants of health, 2nd edn. Oxford, New York: Oxford University Press 2011:6–30.
16 Bair MJ, Robinson RL, Katon W, et al. Depression and pain comorbidity: A literature review. *Arch Intern Med* 2003;163(20):2433–45.
17 Hoy D, Brooks P, Blyth F, et al. The Epidemiology of low back pain. *Best Pract Res Clin Rheumatol* 2010;24(6):769–81.
18 Chou R, Shekelle P. Will this patient develop persistent disabling low back pain? *JAMA* 2010;303(13):1295–302.
19 Brox JI, Storheim K, Holm I, et al. Disability, pain, psychological factors and physical performance in healthy controls, patients with sub-acute and chronic low back pain: a case-control study. *J Rehabil Med* 2005;37(2):95–99.

20 Melloh M, Elfering A, Egli Presland C, et al. Identification of prognostic factors for chronicity in patients with low back pain: a review of screening instruments. *Int Orthop* 2009;33(2):301–13.

21 Wippert P-M, Puschmann A-K, Drießlein D, et al. Development of a Risk Stratification Index and a Risk Prevention Index for chronic low back pain in primary care. Focus: yellow flags (MiSpEx Network). *PAIN-Reports* pub. ahead.

22 UNESCO. International standard classification of education: ISCED 2011. Montreal, Quebec: UNESCO Institute for Statistics 2012.

23 Statistik Austria. ISCO 08- gemeinsame deutschsprachige Titel und Erläuterungen 2011. Available at: http://www.statistik.at/wcm/idc/idcplg?IdcService=GET_PDF_FILE&dDocName=049974.

24 Destatis. Demografische Standards 2017. Available at: https://www.destatis.de/DE/Methoden/DemografischeRegionaleStandards/DemografischeStandardsInfo.html.

25 Lampert T, Kroll LE, Müters S, et al. Messung des sozioökonomischen Status in der Studie "Gesundheit in Deutschland aktuell" (GEDA). *Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz* 2013;56(1):131–43. 23275948.

26 Hollinghead AB. Four Factor Index of Social Status. *Yale Journal of Sociology* 2011;8:21–52.

27 Korff M, Ormel J, Keefe FJ, et al. Grading the severity of chronic pain. *Pain* 1992;50(2):133–49.

28 Schepper EIT de, Damen J, van Meurs JBJ, et al. The association between lumbar disc degeneration and low back pain: The influence of age, gender, and individual radiographic features. *Spine* 2010;35(5):531–36.

29 Breivik H, Collett B, Ventafridda V, et al. Survey of chronic pain in Europe: prevalence, impact on daily life, and treatment. *European Journal of Pain* 2006;10(4):287–333.

30 Präg P, Mills MC, Wittek R. Subjective socioeconomic status and health in cross-national comparison. *Soc Sci Med* 2016;149:84–92.

31 Hoebel J, Müters S, Kuntz B, et al. Messung des subjektiven sozialen Status in der Gesundheitsforschung mit einer deutschen Version der MacArthur Scale. *Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz* 2015;58(7):749–57 (accessed 28 Aug 2015).

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract Check Page 1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found Check Page 2
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported Check Pages 3 and 4
Objectives	3	State specific objectives, including any prespecified hypotheses Check Page 4
Methods		
Study design	4	Present key elements of study design early in the paper Check Title and Pages 4, 5, 6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection Check Pages 4 and 5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants Check Pages 4 and 5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable Check Pages 5 and 6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group Check Pages 5 and 6
Bias	9	Describe any efforts to address potential sources of bias Check Page 6
Study size	10	Explain how the study size was arrived at Check Page 4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why Check Page 6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding Check Page 6
		(*b*) Describe any methods used to examine subgroups and interactions Not applicable
		(*c*) Explain how missing data were addressed Check Page 4
		(*d*) If applicable, describe analytical methods taking account of sampling strategy Not applicable
		(*e*) Describe any sensitivity analyses Not applicable
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed Check Pages 4 and 5
		(b) Give reasons for non-participation at each stage Check Pages 4 and 5
		(c) Consider use of a flow diagram Not used
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders Check Pages 6 and 7
		(b) Indicate number of participants with missing data for each variable of interest Not applicable (all participants with missing data were excluded)
Outcome data	15*	Report numbers of outcome events or summary measures Check Table 2
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included Check Tables 3 and 4

		(*b*) Report category boundaries when continuous variables were categorized Check Table1
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period Not relevant
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses Not applicable
Discussion		
Key results	18	Summarise key results with reference to study objectives Check Page 9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias Check Page 11
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence Check Page 12
Generalisability	21	Discuss the generalisability (external validity) of the study results Check Page 11
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based Check Page 13

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.