Fibromyalgia revisited: do latent class analyses of symptom profiles in the general population confirm 2016 fibromyalgia diagnostic criteria?

B. Schmalbach[1], W. Häuser[2,3], E. Brähler[4], P. Henningsen[2], F. Wolfe[5]

[1]Department of Medical Psychology and Medical Sociology, University Medical Centre of the Johannes Gutenberg University Mainz;
[2]Department of Psychosomatic Medicine and Psychotherapy, Technische Universität München;
[3]Department of Internal Medicine 1, Klinikum Saarbrücken;
[4]Department of Psychosomatic Medicine and Psychotherapy, University Medical Centre of the Johannes Gutenberg University Mainz, Germany;
[5]National Data Bank for Rheumatic Diseases, Wichita, USA.

Bjarne Schmalbach, PhD*
Winfried Häuser, MD*
Elmar Brähler, PhD
Peter Henningsen, MD
Frederick Wolfe, MD

*These authors contributed equally.

Please address correspondence to:
Winfried Häuser,
Department of Psychosomatic Medicine and Psychotherapy,
Technische Universität München,
Langerstrasse 3,
81675 München, Germany.
E-mail:
whaeuser@klinikum-saarbruecken.de

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ABSTRACT

Objective. *The definition of the 2016 diagnostic criteria of fibromyalgia (FM) syndrome and of FM severities was based on studies with clinical samples. We tested if somatic symptom profiles consistent with the symptom pattern of the FM 2016 diagnostic criteria and of severities of FM can be found in the general population.*

Methods. *Somatic symptom burden was measured by the Somatic Symptom Scale - 8 in 2,531 persons aged ≥14 years representative for the general German population. We used latent class analysis of SSS-8 items to identify somatic symptom profiles. The profiles were described by their association with age, gender, self-reported disabling somatic disease, psychological symptom burden, illness worries and self-perceived health.*

Results. *We identified five somatic symptom profiles. The majority of the population (40.9%) had a profile characterised by the absence of bothering symptoms. 5.9% had a profile defined by "considerable bothering" back and extremities pains, fatigue and sleep problems. This symptom profile was associated with older age, self-reported somatic diseases, psychological symptom burden and fair to poor general health. 63.2% of persons meeting FM 2016 criteria belonged to this profile. 17.8% of the sample were characterised by little perturbation by multiple somatic symptoms and good to fair general health. 36.8% of persons meeting FM 2016 criteria belonged to this profile.*

Conclusion. *Two somatic symptom profiles consistent with the 2016 FM diagnostic criteria were identified in the general German population. These symptom profiles differed in somatic and psychological symptom burden and general health supporting the distinction of FM severities.*

Introduction

The definition and content of fibromyalgia (FM) syndrome have changed repeatedly in the 110 years of its existence (1). The most important change arose in the 1990s by the American College of Rheumatology (ACR) classification criteria which defined FM by symptoms (chronic widespread pain [CWP]) and findings (tenderness at palpation of muscles and tendons) (2). By 2010, a second shift occurred that excluded tender points. These new criteria overcame the requirement for specialist medical examinations. Some patient-reported non-musculoskeletal pain symptoms (headache, abdominal pain) and psychological symptoms (fatigue, cognitive problems, depression) were added as minor diagnostic criteria (3). FM became a symptom-based diagnosis that included multiple somatic and psychological symptoms. In the 2016 diagnostic criteria (4), the criteria of CWP was tightened compared to the 1990 classification criteria (2) requiring pain sites in at least four of five body regions.

All studies defining the ACR 1990 classification (2), the 2010 ACR preliminary diagnostic (3), the 2011 (5) and the 2016 (4) criteria were conducted with people with various rheumatic diseases included in the US National Data Bank of Rheumatic Diseases (5). These selections might have led to considerable bias in the identification of symptom classes including higher symptom prevalence in the study population (6). Previous studies have shown a lower symptom burden of FM-cases in the general population compared to the ones of clinical settings (7). A symptom profile in the general population consistent with the one defined by 2016 FM diagnostic criteria (4) would support its use in making a clinical diagnosis of FM.

Studies with FM patients in clinical care have demonstrated that FM is a heterogenous condition with regards to the amount of somatic and psychological symptom burden, disability and comorbid diseases (7). Therefore, a distinction of severities of FM has been suggested, *e.g.* based on clinical criteria such as the extent of disability and /or symptom scores, *e.g.* of the Fibromyalgia Impact Questionnaire (9) or the Patient Health Questionnaire (PHQ) 15 (7, 10). The studies on severities of FM were conducted with clinical populations (7, 9) and require testing in the general population, too.
The latent class approach (LCA) has proven to be a powerful analytical approach for diagnosing symptom patterns in the general population (6, 11). Previous studies have found "healthy", specific symptom and multi-symptom profiles in the general population (6, 12). We studied profiles of somatic symptoms by LCA in the general population in order to assess:

- If profiles which are consistent with the symptom pattern of the 2016 FM criteria can be found;
- If these somatic symptom profiles differ in the amount of somatic and psychological symptom burden and in general health supporting the concept of severities of FM.

Materials and methods

Design and subjects

The study is part of a larger cross-sectional survey on physical and mental well-being, eating behaviour and political attitudes in the German population between May and July 2019. Two studies have been published previously which are based on the same data and thus share parts of the method sections (13, 14). Inclusion criteria were age ≥14 years and the ability to read and understand German. A demographic consulting company (USUMA, Berlin, Germany) assisted with sampling and data collection in a large sample representative for age, gender, and education; according to their established procedure on data collection without any access to population registers, sampling design was conducted in three consecutive steps. First, a sample of 258 living areas was randomly selected from a non-overlapping stratum of all area units: 210 areas were sampled from Western Germany and 48 areas from Eastern Germany. The random selection of households was implemented in the second step. Finally, one person matching the inclusion criteria was randomly selected from each household. Sociodemographic data were collected by trained interviewers face-to-face. In addition, participants completed a battery of self-report questionnaires. The interviewers waited until the participants answered all questionnaires, and offered help in case of ambiguities.

Instruments

Demographics: Age, gender, family status, educational level, and net family income per month were assessed by a standardised questionnaire used previously in German health surveys (15).

The *Somatic Symptom Scale-8* (SSS-8) is the short form of the Patient Health Questionnaire PHQ-15 (10) and asks for eight somatic symptoms during the past 7 days (stomach or bowel problems; back pain; pain in arms, legs, or joints; headaches; chest pain or shortness of breath; dizziness; feeling tired or having low energy; trouble sleeping). Symptoms are scored on Likert Scales from 0 (not bothered at all) to 4 (bothered very much) (16). We recoded as follows: 0=0; 1 and 2=1; 3 and 4=2 because a) 4-scores were very rare (<10) for some items increasing the risk of imprecision of the model estimation b) We wanted to provide comparability with a previous study which used the PHQ-15 to assess somatic symptom profiles (12). Somatic symptom burden in the 0-4 scale can be categorised as follows: Minimal: 0-3; low; 4-7; medium: 8-11; High: 12-15; Very high: 16-32. We modified the categories based on the 0-2 scale as follows: 0-2: Minimal; 3-4: Low; 5-6: Moderate; 7-9: High; 10-12: Very high.

The *Bodily Distress Syndrome Checklist (BDS-25)* is a self-report instrument for the identification of BDS in clinical care and research by asking for 25 cardiopulmonary, gastrointestinal, musculoskeletal and general symptoms during the last four weeks. Thus, the BDS-25 asks for negative appraisal of somatic symptoms, but not explicitly for psycho-behavioural symptoms. Each symptom can be scored on Likert Scales from 0 (bothering not at all) to 4 (bothering a lot) (17). We used the validated German version of the BDS-25 (13).

The *Patient Health Questionnaire-4 (PHQ-4)* was used to assess psychological symptom burden. On Likert scales from 0 (not at all) to 3 (nearly every day), respondents rate how often they have been bothered by little interest or pleasure in doing things and feeling down, depressed or hopeless, feeling nervous, anxious or on edge, or not being able to stop or control worrying over the last two weeks. The total score ranges from 0 to 12. Scores are rated as normal (0-2), mild (3-5), moderate (6-8), and severe (9-12) psychological symptom burden (18). We used the validated German version (19).

The *Michigan Body Map (MBM)* is a graphic mannequin for the assessment of chronic pain. It offers 35 checkbox body areas covering all 19 areas from the Widespread Pain Index (WPI) (4) plus 16 other pain sites (20). Subjects are asked to mark all areas where they have felt persistent or recurrent pain present for the last three months or longer. We used the German version of the MBM. To follow FM 2016 criteria, pain locations were summarised to 5 global pain regions (axial, left upper, right upper, left lower, right lower) and WPI pain sites were counted, excluding jaw, chest, and abdominal pain sites.

The *Whiteley Index (WI-7)* assesses illness conviction and illness worrying (21). Seven questions (*e.g.* "do you think there is something seriously wrong with your body?" and "do you worry a lot about your health?" are answered in a dichotomous format (0=no; 1=yes), resulting in a total score between 0 (low illness conviction/worrying) and 7 (high illness conviction/worrying). We removed WI-7 items 5 and 7 ("Are you bothered by many aches

and pains?"; "Do you find that you are bothered by many different symptoms?") because they capture symptom quantity rather than illness conviction (WI-5). We used the validated German version (22).

The *self-administered comorbidity questionnaire (SCQ)* is a validated self-rating instrument in clinical and health services research to assess common diseases. It asks about the presence, treatment, and functional limitations of thirteen common diseases (heart disease; high blood pressure; lung disease; diabetes; ulcer or other stomach disease; kidney disease; liver disease; anaemia or other blood disease; cancer; rheumatoid arthritis. We substituted osteoarthritis by pancreas disease and low back pain by inflammatory bowel disease to a) avoid overlap with pain sites assessed by the WPI b) to increase the number of somatic diseases which might contribute to somatic symptoms captured by the BDS 25 checklist. Three subscales (present disease, present disease with drug treatment, present disease with associated disability) are available (23). We used the subscale "present disease with associated disability" (range 0-12) of the validated German version (24).

The *Short Health Survey 12 (SF-12) General Health* concept was used to assess self-perceived health on a 5-point Likert scale. Subjects were straight asked "In general, would you say your health is….". The answers are as follows: 1=excellent; 2=very good; 3=good; 4= moderate; 5=poor self-perceived health' (25). We used the validated German version (26).

Case definitions of FM

We used two case definitions of FM because: a) there is no gold standard for FM diagnosis; b) considerable disagreement between clinical diagnosis and criteria-based diagnosis of fibromyalgia was found in an US rheumatology clinic (27).

2016 criteria: MBM pain sites and pain regions were counted (excluding jaw, chest, and abdominal pain). In addition, the Somatic Severity Scale (SSS) criteria of the 2011 diagnostic criteria of FM (5) were recorded as follows: Fatigue and sleeping problems when reported by SSS-8 items 7 and 8 as at least "somewhat bothering"**;** cognitive problems when reported BDS item 24 was rated as at least "somewhat bothering; headache when BDS 25 item 23 was rated as at least "somewhat bothering"; pain or cramps in the lower abdomen when BDS 25 item 8 was rated as at least "somewhat bothering"; depression when PHQ 4 item 2 was rated as at least "at several days". Scores of ACRSSS range from 0-12. Polysymptomatic Distress Scale score (PDS) is the sum of the WPI and SSS. Scores range from 0-31. We used these PPS severity categories: none (0-3), mild (4-7), moderate (8-11), severe (12-19), and very severe (20-31). FM was defined as 1) WPI ≥ 7 and SSS ≥5 OR WPI 4-6 and SSS ≥9, AND 2) pain in 4 of 5 body regions (4).

Self-reported FM: Participants were asked if they have been diagnosed with FM by a physician in the past.

Table I. Fit criteria for latent class models with 1-10 components.

# of latent clusters	*LL*	*df*	*BIC*	*CAIC*
1	-14016.07	2363	28156.53	28172.53
2	-11944.48	2346	24145.52	24178.52
3	-11567.86	2329	23524.44	23574.44
4	-11408.47	2312	23337.82	23404.82
5	**-11302.05**	**2295**	**23257.16**	**23341.16**
6	-11239.02	2278	23263.26	23364.26
7	-11189.62	2261	23296.63	23414.63
8	-11160.14	2244	23369.82	23504.82
9	-11131.24	2227	23444.19	23596.19
10	-11103.44	2210	23520.76	23689.76

LL: log likelihood; df: degrees of freedom; BIC: Bayesian information criterion; CAIC: consistent Akaike information criterion.
Model with best fit is printed in bold.

Statistical analyses

All analyses were conducted in R. Only complete cases were included: n = 2,379. We then utilised *poLCA* (28) to perform a latent class analysis with the items of the SSS-8. This technique allows for the clustering of observations with regard to a given number of characteristics. Prior to computing the LCA model, we tested the assumption of conditional independence, which was met with only minor deviations for the indicators. This means that, after accounting for classification the indicator variables should only be related to a negligible degree (similar to the error terms in confirmatory factor analysis). The primary measures of interest in the LCA are then the Bayesian Information Criterion (*BIC*) and the Consistent Akaike Information Criterion (*CAIC*). In line with the typical recommendation, we also ran bootstrapped (i=100) LCAs to ascertain the initial results (29).

Subsequently, we compared the resulting classes with regard to their sociodemographic characteristics as well as their descriptive statistics for both, the SSS-8 items and scales, and other related measures and variables. For metric variables, we used univariate ANOVAs and report the η^2 effect size, which according to Cohen (30, 31) should be interpreted as signifying small, moderate, and large effects for values exceeding 0.01, 0.09, 0.25. In addition, we conducted *post-hoc* group comparisons using Holm-corrected t-tests.

For count variables, we utilised the χ^2 test to investigate whether there are significant between-group differences. We report Cramer's V as an effect size for these analyses, which is defined as the root of χ^2 divided by the product of the sample size and dfA, where dfA is the length of the smaller of the two dimensions minus 1 (30). In addition, we applied the correction suggested by Bergsma (32) which delivers a more accurate estimate of the population effect size. For dfA = 1, Cramer's V is interpreted analogously to the Pearson r coefficient with small, moderate, and large effects being identified by values of 0.10, 0.30, and 0.50, respectively.

Table II. Relative response frequencies for the SSS-8 items.

		Total sample	1	2	3	4	5	Group comparison
Item	n	2379	973	435	424	407	140	
	%	100	41	18	18	17	6	
Stomach or bowel problems	Not at all	72	95	63	76	34	28	$\chi^2(8) = 140.47$, $p<0.001$, $V = 0.364$
	A little	26	5	34	24	65	49	
	A lot	2	0	3	1	1	23	
Back pain	Not at all	49	90	55	6	1	10	$\chi^2(8) = 206.58$, $p<0.001$, $V = 0.447$
	A little	44	10	45	87	79	36	
	A lot	8	0	0	7	20	54	
Pain in your arms, legs, or joints	Not at all	65	97	92	39	5	11	$\chi^2(8) = 219.21$, $p<0.001$, $V = 0.461$
	A little	29	2	6	57	83	37	
	A lot	6	1	2	4	12	51	
Headaches	Not at all	57	87	34	52	29	11	$\chi^2(8) = 116.73$, $p<0.001$, $V = 0.330$
	A little	39	13	60	47	68	51	
	A lot	4	0	6	1	4	39	
Chest pain or shortness of breath	Not at all	83	99	90	93	49	26	$\chi^2(8) = 199.87$, $p<0.001$, $V = 0.439$
	A little	14	1	9	6	48	53	
	A lot	2	0	1	0	3	21	
Dizziness	Not at all	84	100	80	94	57	29	$\chi^2(8) = 187.19$, $p<0.001$, $V = 0.425$
	A little	15	0	20	5	43	51	
	A lot	1	0	0	0	0	20	
Feeling tired or having low energy	Not at all	56	96	9	81	4	6	$\chi^2(8) = 108.36$, $p<0.001$, $V = 0.318$
	A little	37	4	84	19	91	12	
	A lot	7	0	6	0	5	82	
Trouble sleeping	Not at all	66	98	41	87	16	7	$\chi^2(8) = 118.22$, $p<0.001$, $V = 0.333$
	A little	28	2	56	13	78	23	
	A lot	6	0	3	0	6	70	

As dfA increases, these interpretation guidelines are attenuated by a divisor of √dfA. In the case of the present investigation the maximal dfA is 4, which implies a halving of the guidelines to 0.05, 0.15, and 0.25.

Ethics

All participants were informed about the study procedures and gave informed consent form. For underage participants, written informed consent was obtained from a parent and/or legal guardian. The study was approved by the Institutional Ethics Review Board of the University of Leipzig (Az 145/19-ek). All methods were carried out in accordance with relevant guidelines and regulations.

Results

Study sample

The data of the present investigation was collected in May and July 2019. 5,393 addresses were initially contacted, and 2,531 individuals (46.9%) finally took part in the study. Non-participation reasons included: the household or selected household member refused to participate (22.9%); four unsuccessful attempts to contact the household or selected household member (13.6%); selected household member refused interview (12.3%); four unsuccessful attempts to meet the selected household member (3.0%); the selected household member was on vacation (0.6%) or ill and unable to follow the interview (0.5%). Nine interviews (0.2%) were unsuited for analysis. In terms of sex ratio, age groups, and education, the study sample was comparable to the general German population as assessed by the Federal Statistical Office.

Latent class analyses

Initially, we ran a latent class analysis to identify the number of classes that represents the sample under consideration with the least information lost. To this end, we compared log likelihood, *BIC*, and *CAIC* between models of 1 to 10 classes. As can be seen in Table I, five classes were the best representation for the data at hand. To check these results, we then conducted a bootstrapping analysis. Out of the 100 iterations, 98 replicated the initial finding, while two iterations gave evidence for a four-class solution. As a result, we accepted five classes as the ideal solution.

Symptom classes

Being considerably bothered by at least one symptom during the 7 days preceding the survey was reported by 8.4% of the persons, and 1.9% reported being considerably bothered by three or more symptoms. Back pain, headaches and fatigue were the most frequently reported bothering symptoms reported by the participants.

The five classes can be characterised based on the SSS-8 as follows (Table II):

Class 1 (40.9% of the study sample): Majority of participants not bothered at all by somatic symptoms; minimal average somatic symptom burden ("Healthy profile");

Class 2 (18.3% of the study sample): Majority of participants bothered a little bit by headaches, fatigue and sleep problems; low average somatic symptom burden ("Headache profile");

Table III. Sociodemographic characteristics for the overall sample and the latent classes.

	Total		Profile 1	Profile 2	Profile 3	Profile 4	Profile 5	Group-comparison
n	2379	-	973	435	424	407	140	
%	-	100	41	18	18	17	6	
Sex								$\chi^2(4) = 7.68, p=0.104, V = 0.086$
Male	1116	47	54	36	53	39	35	
Female	1263	53	46	64	47	61	65	
Age								$F(4, 2374) = 74.70, p<0.001, \eta^2 = 0.112$
M	48.29	-	43.33	43.77	53.79	57.71	52.72	
SD	17.83	-	16.78	17.16	15.90	16.90	18.41	
Family status								$\chi^2(20) = 123.49, p<0.001, V = 0.229$
Married	1045	44	45	39	50	43	34	
Separated	67	3	2	3	3	4	3	
Unmarried, living alone	463	19	26	21	10	13	19	
Divorced	341	14	11	16	15	19	21	
Widowed	205	9	5	6	12	16	14	
Unmarried, living with partner	247	10	12	14	9	5	9	
Monthly household income								$\chi^2(8) = 17.57, p=0.025, V = 0.098$
< 1500 €	551	23	18	24	20	31	44	
1500-3499 €	1315	55	58	53	59	52	41	
≥ 3500 €	513	22	24	23	21	16	16	

Class 3 (17.8% of the study sample): Majority of participants bothered a little bit by pain in back and extremities; low average symptom burden ("Musculoskeletal profile");
Class 4 (17.1% of the study sample): Majority of participants bothered a little bit by all somatic symptoms except dizziness and shortness of breath; high average somatic symptom burden ("Multiple somatic symptoms profile");
Class 5 (5.9% of the study sample): Majority of participants bothered a lot by pain in back and extremities, fatigue and sleep problems and very high average somatic symptom burden ("Musculoskeletal/ fatigue-profile").
The five classes can be characterised based on associated demographic, physical and psychological findings as follows (Tables III-V):
Class 1: Gender ratio nearly equal. Members younger than the average of the total sample; no pain sites in the WPI; no polysymptomatic distress (PDS); no psychological symptom burden (PHQ4); no illness worries (WI-5); no self-reported disabling somatic diseases; good subjective health.
Class 2: Gender ratio with predominance of women; members younger than the average of the total sample; no pain sites in the WPI; mild polysymptomatic distress (PDS); no psychological symptom burden (PHQ4); no illness worries (WI-5); no self-reported disabling somatic diseases; good subjective health.
Class 3: Gender ratio nearly equal; members older than the average of the total sample; no pain sites in the WPI; no polysymptomatic distress (PDS); no psychological symptom burden (PHQ4); no illness worries (WI-5); no self-reported disabling somatic diseases, good subjective health.
Class 4: Gender ratio with predominance of women; Members older than the average of the total sample; multiple pain sites in the WPI; mild polysymptomatic distress (PDS); mild psychological symptom burden (PHQ4); illness worries (WI-5); one self-reported disabling somatic diseases; good subjective health.
Class 5: Gender ratio with predominance of women; members older than the average of the total sample; multiple pain sites in the WPI; severe polysymptomatic distress (PDS); mild psychological symptom burden (PHQ4); illness worries (WI-5); two self-reported disabling diseases; moderate subjective health.
The effect sizes of the overall difference in age and gender were moderate, in marital status it was small and not substantial for the monthly household net income (Table III). The effect size of the overall group difference for psychological symptom (PHQ-4) burden and number of self-reported disabling somatic diseases was small, for number of pain sites (WPI), illness worries (WI-5) and general health was moderate and for somatic symptom burden measured by ACRSSS, SSS-8 and PDS was large (Table IV). Participants in the musculoskeletal/fatigue-profile had highest scores in all outcomes, followed by the participants in the multi-symptom profile and by participants in the musculoskeletal profile.
2.9% of participants of the study sample met the 2016 criteria of FM. 1.2% of participants of the study sample reported to have been diagnosed with FM by a physician. Of these 29 participants, 44.8% met the 2016 criteria of FM. 36.8% of participants meeting FM 2016 criteria were found in the multiple somatic symptoms and 63.2% in the musculoskeletal pain/fatigue-profile. Of participants with self-reported FM-diagnosis, 17.2% were found in the musculoskeletal profile, 31.0% in the multiple somatic symptoms and 44.8% in the musculoskeletal pain/fatigue-profile.

Discussion

Summary of main results

By latent class analysis, we found asymptomatic, symptom specific and multiple somatic symptom profiles in

Table IV. Mean values and standard deviations SSS-8 scale score and external criteria.

	Total	Profile 1	Profile 2	Profile 3	Profile 4	Profile 5	Group comparison	Pairwise comparisons*
SSS-8 (0-16) (Mean, SD)	3.05 (3.06)	0.39 (0.55)	3.57 (1.24)	2.84 (0.94)	6.57 (1.46)	10.33 (2.07)	$F(4, 2374) = 4135.52$, $p<0.001$, $\eta^2 = 0.874$	1 < 3 < 2 < 4 < 5
WPI (0-19); *M*(*SD*)	1.00 (2.31)	0.05 (0.31)	0.38 (0.94)	0.89 (1.58)	2.83 (3.29)	4.59 (4.26)	$F(4, 2374) = 296.24$, $p<0.001$, $\eta^2 = 0.333$	1 = 2 < 3 < 4 < 5
ACRSSS (0-12); *M*(*SD*)	1.75 (2.43)	0.14 (0.41)	2.61 (1.65)	0.67 (0.92)	3.69 (1.82)	7.88 (2.43)	$F(4, 2374) = 1551.70$, $p<0.001$, $\eta^2 = 0.723$	1 < 3 < 2 < 4 < 5
PSD (0-31); *M*(*SD*)	2.89 (4.27)	0.21 (0.55)	3.03 (2.09)	1.78 (2.07)	6.89 (4.26)	12.89 (5.27)	$F(4, 2374) = 1092.31$, $p<0.001$, $\eta^2 = 0.648$	1 < 3 < 2 < 4 < 5
PHQ 4 (0-12), M (SD)	1.55 (2.12)	0.60 (1.36)	1.99 (2.08)	1.14 (1.54)	2.66 (2.02)	4.85 (3.00)	$F(4, 2374) = 239.37$, $p<0.001$, $\eta^2 = 0.287$	1 < 3 < 2 < 4 < 5
Whiteley 5- Index (0-5); M (SD)	0.84 (1.40)	0.21 (0.67)	0.87 (1.31)	0.61 (1.06)	1.81 (1.73)	2.98 (1.54)	$F(4, 2374) = 265.70$, $p<0.001$, $\eta^2 = 0.309$	1 < 3 = 2 < 4 < 5
Number of self-reported disabling Somatic diseases (0-12), M (SD)	0.46 (1.25)	0.17 (1.12)	0.32 (0.99)	0.41 (0.89)	1.06 (1.34)	1.79 (1.98)	$F(4, 2374) = 88.24$, $p<0.001$, $\eta^2 = 0.129$	1 = 2 = 3 < 4 < 5
SF-12 general health (1-5); M (SD)	2.63 (0.97)	1.99 (0.75)	2.70 (0.74)	2.81 (0.73)	3.39 (0.70)	4.05 (0.76)	$F(4, 2374) = 429.00$, $p<0.001$, $\eta^2 = 0.420$	1 < 2 = 3 < 4 < 5

For the SF-12, higher values indicate worse general health.
*The pairwise comparisons denote significant differences ($p<0.001$) between classes in the specified order.
ACRSSS: American College of Rheumatology Somatic Severity Scale; PDS: Polysymptomatic Distress Scale; PHQ: Patient Health Questionnaire; SF: Short Form Health Survey: SSS: Somatic Symptom Scale; WPI: Widespread Pain Index.

the general German population. Participants meeting 2016 FM diagnostic and self-reported FM criteria were found in musculoskeletal profile, multiple somatic symptoms and musculoskeletal pain / fatigue profiles. These FM-like profiles were associated with older age, female gender, higher psychological symptom burden, more self-reported somatic diseases and poorer general health compared to symptom specific and healthy profiles.

Comparison with other studies

We are only aware of two studies which assessed somatic symptom profiles in the general population by LCA. Eliasen *et al*. (6) found eight profiles in 19 self-reported common somatic symptoms by participants of the general Danish population. Five profiles were mainly characterised by high probabilities for symptoms from one body part/organ system: headache, musculoskeletal, gastrointestinal, pulmonary. Three profiles were characterised by multiple symptoms: musculoskeletal, fatigue, headache; musculoskeletal, fatigue, headache, gastrointestinal and all symptoms. Wirtz *et al*. (12) studied somatic symptoms of people aged 60 to 85 years in the general German population with the PHQ 15. Six symptom classes were identified: healthy; musculoskeletal symptoms; musculoskeletal and respiratory/cardiac symptoms; musculoskeletal and respiratory symptoms, along with bowel and digestion problems; all somatic symptoms; all somatic symptoms except bowel problems. Taken together, a symptom-free (healthy) symptom profile, a musculoskeletal symptom profile and multiple somatic symptoms profiles were found by all LCA - studies in the general population.

The prevalence of a multiple somatic symptoms profile with reduced general health was 3.9% in the study of Eliasen (6) and 5.9% in our sample.

In our study, we found all FM 2016 cases in two somatic symptoms profiles. The majority of participants in profile 4 was bothered a little bit by multiple somatic symptoms. The majority of participants in profile 5 was bothered a lot by back and extremities pain, fatigue and sleep problems. Both profiles comprise the main (multisite musculoskeletal pain, fatigue and sleep problems) and minor 2016 FM criteria symptoms (headache, abdominal pain). Thus, the 2016 FM diagnostic criteria of FM (4) could be replicated in somatic symptom profiles in the general population.

In line with our findings of two previous German population (15, 33) surveys which used the Katz (34) and 2011 criteria (5), FM-cases were characterised older age, female gender, higher somatic and psychological symptom burden and reduced self-perceived health compared with non-FM cases. Taken together, persons meeting any FM criteria in German population studies were at the end of a continuum of biopsychosocial distress. However, FM-cases in our study differed in the amount of somatic and psychological symptom burden supporting the concept to distinguish different severities of FM (4, 35) and to offer graduated treatment approaches according to the severity of FM with severe forms of FM requiring multicomponent and multidisciplinary therapy (35, 36).

Limitations

The seemingly low response rate of 47% could affect the generalisability of the study results. However, response rates in population studies are generally lower than those in clinical studies, and our response rate is above the average rates of questionnaire surveys (ranging between 45% and 50%) (37). Nursing home residents and inpatients were not included in our study. The

Table V. Relative response frequencies for the SSS-8 scale score and external criteria.

	Total	Profile 1	Profile 2	Profile 3	Profile 4	Profile 5	Group comparison
%	100	41	18	18	17	6	
SSS-8 (0-15)							
0-3	64	100	54	75	0	0	$\chi^2(16) = 588.38, p<0.001, V = 0.537$
4-7	26	0	46	25	73	6	
8-11	9	0	0	0	27	69	
12-15	1	0	0	0	0	25	
>15	0	0	0	0	0	1	
WPI (0-19)							
0	72	96	80	63	31	20	$\chi^2(12) = 166.61, p<0.001, V = 0.321$
1	8	3	10	15	13	11	
2-5	14	1	10	20	39	31	
>5	6	0	0	2	18	39	
PSD (0-31)							
0-3	72	100	69	83	23	1	$\chi^2(16) = 409.71, p<0.001, V = 0.446$
4-7	15	0	28	14	40	14	
8-11	7	0	3	2	23	29	
12-19	5	0	0	0	12	46	
20-31	1	0	0	0	1	10	
PHQ-4 (0-4)							
0-2	74	91	66	84	49	21	$\chi^2(12) = 151.20, p<0.001, V = 0.306$
3-5	21	8	29	13	43	41	
6-8	4	1	4	2	7	28	
9-12	1	0	1	0	1	10	
WI-5 (0-5)							
0	65	86	59	67	37	8	$\chi^2(12) = 108.30, p<0.001, V = 0.254$
1	13	10	18	17	12	13	
2	7	2	10	7	16	14	
>2	15	2	13	9	36	66	
Self-reported disabling somatic diseases (0-12)							
High blood pressure	19	5	16	24	42	45	$\chi^2(44) = 380.13, p<0.001, V = 0.475$
Heart disease	6	1	3	2	16	26	
Diabetes	6	2	4	6	13	26	
Cancer	1	1	1	1	3	4	
Inflammatory bowel disease	2	1	1	1	3	6	
Lung disease	2	1	4	0	4	10	
Kidney disease	2	1	0	1	3	6	
Liver disease	1	1	1	0	2	6	
Ulcus or other stomach disease	3	1	2	1	6	11	
Anemia or other blood disease	1	1	1	1	1	6	
Inflammatory rheumatic disease	5	1	1	3	12	25	
Pancreas disease	1	1	1	0	1	7	
SF-12 general health							
Excellent	13	28	6	5	0	0	$\chi^2(16) = 342.84, p<0.001, V = 0.405$
Very good	30	47	29	22	8	4	
Good	40	24	55	62	48	16	
Fair	14	1	10	10	41	53	
Poor	3	0	0	1	3	28	
FMS 2016 criteria positive	3	0	0	0	6	31	$\chi^2(4) = 105.54, p<0.001, V = 0.459$
Self-reported FMS-diagnosis	1	0	0	1	2	9	$\chi^2(4) = 24.42, p<0.001, V = 0.221$

For the SF-12, higher values indicate worse general health.

participants could be expected to be healthier than non-participants.

There is no gold standard for the diagnosis of FM (35). We tested the 2016 criteria (4), but not other criteria.

We used similar variables for the FM 2016 symptom scales, but not the wording used in the 2016 criteria paper (4).

The study design excluded medical examination. Therefore, the self-reported disabling somatic diseases could not be validated.

Some of the profiles could be a result of chance findings or triggered by the selection of somatic symptoms in the SSS-8. It comprises only eight symptoms. Thus, the possibility of identifying nuanced and multiple profiles is decreased. Eliasen *et al*. identified eight symptom classes by including 19 symptoms (6) and Wirtz *et al*. found

six symptom classes by including 15 symptoms in LCA (12).

The identified profiles may describe clinical recognisable symptom patterns from well-defined somatic diseases, symptom-based diagnoses and short-term unspecific symptoms. The symptom profiles should not be interpreted as definitions of diseases or new classifications of disorders but as complexes of considerably bothering somatic symptoms of different origin (6).

Conclusions

Latent class analyses separated the continuum of somatic symptom burden in the general German population into clinically meaningful profiles.

FM appears to be an invisible experience without any visible biomarker to exhibit to healthcare professionals (38). We identified a somatic symptom profile consistent with the major symptoms of FM according to the 2016 diagnostic criteria (widespread pain, fatigue and sleep problems) in the general population supporting a specific diagnostic code for FM in the upcoming International Classification of Diseases (ICD-11) of the World Health Organisation (39).

As in clinical populations, FM 2016 cases in the general population differed in the amount of additional and psychological symptom burden, subjective health and comorbid somatic diseases. The heterogeneity of FM should be addressed by targeted and graduated management approaches (35, 36).

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