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Title:

Patterns of multiple lifestyle risk factors and their link to mental health: a latent class analysis in the German adult population

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ABSTRACT

Objectives: Lifestyle risk factors, such as drinking or unhealthy diet can expotentiate detrimental health effects. Therefore, it is important to investigate multiple lifestyle risk factors instead of single ones. The study aims at 1) identifying patterns of lifestyle risk factors within the adult general population in Germany, and at 2) examining associations between the extracted patterns and external factors.

Design: Cross-sectional study

Setting: General German adult population (aged 18 – 64 years).

Participants: Participants of the 2015 Epidemiological Survey of Substance Abuse (ESA) (n = 9204).

Primary outcome measures: Lifestyle risk factors (daily smoking, at risk alcohol consumption, unhealthy diet, low physical activity, weekly use of pharmaceuticals, as well as consumption of cannabis and other illicit drugs).

Results: A total of four classes were extracted which can be described as healthy lifestyle (58.5 %), drinking lifestyle (24.4 %), smoking lifestyle (15.4 %), and polysubstance use lifestyle (1.7 %). Individuals who were male, at younger age and single as well as individuals with various mental health problems were more likely to show multiple lifestyle risk factors.

Conclusions: Health-care professionals should be aware of correlations between different lifestyle risk factors as well as between lifestyle risk groups and mental health. Health promotion strategies should further focus especially on younger and single men.

Keywords: epidemiology, health behaviour, lifestyle, mental health, population survey

STRENGTHS AND LIMITATIONS OF THIS STUDY

- First study about multiple lifestyle risk factors in the general German adult population using national representative data
- We conducted a latent class analysis including the usage of illicit drugs and pharmaceuticals as lifestyle risk factors, which has been rarely done before
- We assessed associations between lifestyle risk groups and external factors such as mental health, physical health, and sociodemographic factors
- The study design of the ESA is not able to reach certain subgroups with increased rates of substance consumption i.e. homeless people or inmates

INTRODUCTION

Lifestyle risk factors, like unhealthy diet, low physical activity as well as the consumption of legal and illicit substances are related to the development of several noncommunicable diseases such as cancer and cardiovascular diseases [1, 2]. In 2012, noncommunicable diseases accounted for 68% (n = 38.0 million) of deaths worldwide [3]. Therefore, lifestyle risk factors entail significant costs for a society and its economy. Germany's economic costs due to drinking and smoking are estimated at about 26 – 79 billion euro per year, respectively [4, 5].

Previous literature shows that lifestyle risk factors are associated with each other [6, 7]. Due to the fact that multiple lifestyle risk factors are more detrimental to health compared with single lifestyle risk factors [8, 9], the identification of risk clusters might facilitate the development of specific health promotion strategies for different vulnerable population groups. Two German studies examined patterns of health behaviour in a sample of job-seekers [10] and in an older (50 years and more) population [11]. For example, Schneider and colleagues [11] identified five different clusters: a cluster with no risk behaviour (25.3 %), a cluster with drinkers (22.7 %), a physically inactive cluster (21.1 %), a cluster with fruit and vegetable avoiders (18.2 %) and a cluster with smokers (12.7 %). In contrast, Schnuerer and colleagues [10] revealed three clusters (substance use, non-exercising overweight, health-conscious).

Neither Schnuerer [10] nor Schneider [11] included illicit drugs in their analyses, although associations between cannabis and other substances, like alcohol, tobacco or pharmaceuticals, are often addressed in the scientific literature [12, 13, 14, 15]. In the 2015 German Epidemiological Survey of Substance Abuse (ESA 2015), analgesics were the most commonly used substance after alcohol in Germany [16]. Furthermore, with a prevalence of 7.4%, cannabis was the most widely used illicit drug in the last 12 months. Given that, it seems both timely and useful that these substances are taken into account for the examination of certain patterns of lifestyle risk factors.

Clusters with high prevalence rates for lifestyle risk factors are associated with younger age, male gender, lower levels of education [7] and mental disorders (i.e. major depression) [17, 18]. Additionally, lifestyle risk factors are associated with self-rated health. For instance, a positive state of health seems to be correlated with low to zero consumption of alcohol and tobacco as well as with healthy nutrition and high physical activity [19, 20].

Evidence on the link between multiple lifestyle risk factors, mental disorders and self-rated health which is representative of the general population is currently not available for Germany. The first aim of this study was to assess patterns of multiple lifestyle risk factors (smoking, alcohol consumption, unhealthy diet, low physical activity, consumption of cannabis and other illicit drugs, use of

pharmaceuticals) in a nationwide sample in Germany. Secondly, the study examined if the extracted health lifestyle classes were associated with external factors like sociodemographic factors, self-related health, and mental health problems.

METHODS

Sample and procedure

The present study is based on data from the 2015 Epidemiological Survey of Substance Abuse (ESA 2015). The ESA is a population-representative cross-sectional survey assessing substance use among the general population in Germany [23]. The adjusted sample (weighted for region, age, gender and education) comprised 9,204 persons aged 18 to 64 years. Paper-and-pencil, telephone and internet-based methods were used to collect the data (net response rate = 52.2%). The ESA 2015 was conducted according to the principles of the Declaration of Helsinki. Overall, 5090 women (49.6%) and 4114 men (50.4%) with an average age of 38.3 years (SD = 14.7) participated in this study. A more detailed description of methodology and design of the ESA 2015 can be found in Piontek and colleagues [21].

Selected variables for LCA (lifestyle risk factors)

To assess patterns of multiple lifestyle risk factors, eight variables were selected: smoking, alcohol consumption, episodic heavy drinking, diet, physical activity as well as the consumption of cannabis, other illicit drugs, and pharmaceuticals (analgesics, hypnotics or tranquilizer). All variables were dichotomized (0/1), and assessed whether respondents showed lifestyle risk factors (coded “1”) or favorable lifestyle behaviours (coded “0”).

Risky tobacco consumption was defined as daily smoking of cigarettes, cigars, pipes or cigarillos within the last 30 days. Alcohol consumption was measured using a quantity-frequency-index. The daily consumption of 12 grams (women) or 24 grams (men) of pure alcohol within the last 30 days was characterized as risky alcohol consumption. Episodic heavy drinking (EHD) was defined as consumption of five or more drinks of alcohol consumed on a single day (last 30 days). The consumption of cannabis and other illicit drugs (amphetamines, ecstasy, LSD, heroin and other opioids, cocaine, crack, mushrooms) as well as the weekly consumption of non-prescribed analgesics, hypnotics or tranquilizers within the last 30 days were defined as lifestyle risk factors. Analgesics included opioid as well as non-opioid drugs.

The rationale for lifestyle risk factors considering physical activity and nutrition was based on guidelines [22, 23]. Physical activity was measured as being breathless and sweating through physical

activity for at least 30 minutes per day on five days per week (last three months). Physical activity for less than 30 min per day on five days per week was classified as a lifestyle risk factor. Diet was assessed using a validated food frequency questionnaire of six items, asking how often somebody would eat low fat milk products, fresh salads, herbs, fresh fruits and cereal products. The response categories ranged from 1 (rarely or never) to 5 (several times a day). A nutrition index was calculated [22] whereby a low index score (< 10) corresponded to an unhealthy diet and was seen as a lifestyle risk factor.

Selected variables for associations with extracted classes (predictors)

The following variables were selected to examine the association of the health lifestyle classes with external factors: sociodemographic factors, self-rated physical health (1 very good – 5 very bad), self-rated mental health (1 very good – 5 very bad), neurological diseases (no/yes), and a broad range of mental health problems within the last 12 months (i.e. depression).

To screen for mental health problems in the past 12 months, screening questions of the following sections of the Munich Composite Diagnostic International Interview (M-CIDI) [24] were used: panic attacks, general anxiety, social phobia, anxiety of public places, specific phobia, depression, mania and trauma. Furthermore, the respondents were asked whether they were in treatment for mental health problems or had been diagnosed with a mental disorder. All variables were dichotomized (no/yes).

Sociodemographic information was assessed by questions about gender (male, female), age (18 – 64 years), marital status (single, married, divorced, widowed) and education (low, average, high). Education was categorized into three groups according to the International Standard Classification of Education (ISCED) [25].

Data analysis

A latent class analysis (LCA) was performed on eight categorical lifestyle risk factors as described above. Goodness-of-fit measures (Bayesian Information Criterion (BIC), Entropy, Vuong-Lo-Mendell-Rubin adjusted Likelihood-Ratio-test (VLMR)) were used to select the best model. A low BIC, high Entropy and a significant VLMR indicate the best class-solution, but the final decision was also based on the researchers' assessment of the interpretability of the results. We tested models with up to five classes. Multiple sets of random starting values (6000 300), a high number of iterations (100) and a tight convergence criterion (1.E-10) were used to avoid local maxima. The analysis was performed in MPlus using sampling weights and a complex mixture term, which refers to the complex sampling of the ESA data [26].

The conditional class membership probabilities were further used for a multinomial logistic regression testing for associations of the classes with external factors (e.g. sociodemographic factors, mental health problems) as described above. Classes were used as outcome variables. Control variables were region, citizenship and mode of interview (paper-and-pencil, telephone, internet-based). The class with individuals showing mostly a healthy lifestyle class was used as reference category. Risk ratios as well as 95%-confidence intervals were calculated while using sampling weights and a complex mixture term to adjust standard errors. There was no sign of multicollinearity among the independent variables. The regression model was run in STATA 12.1 SE (Stata Corp LP; College Station, TX).

RESULTS

Respondent characteristics

In total, low physical activity (82.6 %) and unhealthy diet (69.9 %) were the two most prevalent lifestyle risk factors (Table 1). The lowest prevalence rates were reported for the use of illicit drugs (0.8 %) and the use of cannabis (3.1%). About one quarter of the respondents reported episodic heavy drinking and one fifth reported daily smoking.

Table 1

Weighted prevalence rates for lifestyle risk factors (n = 9204)

Risk factors	Total		
	N	%	95%-CI
Daily Smoking	1322	18.5	[17.3,19.8]
At-risk drinking	1416	15.3	[14.4,16.3]
Episodic heavy drinking	2513	25.3	[24.0,26.7]
Cannabis use	386	3.1	[2.7,3.6]
Other illicit drugs use	75	0.8	[0.6,1.1]
Weekly pharmaceuticals use	733	8.2	[7.5,8.9]
Unhealthy diet	6185	69.9	[68.8,71.0]
Low physical activity	6423	82.6	[81.5,83.7]

Note. n = observed frequency of lifestyle risk factors, % = prevalence rates, 95%-CI = confidence intervals; weighted for age, region, gender and education.

Latent class analysis and class profiles

Latent class models with one to five classes were estimated. Although the Entropy indicated a 3-class solution, the 4-class solution was selected as the final model due to better values of BIC, VLMR and the estimated class-specific response probabilities (> 0.8) (Table 2). The bivariate residual statistics showed minor violations (> 1.96) regarding the assumption of local independence in all classes (not shown) and therefore did not affect the selection of the final model.

Table 2

Goodness-of-fit measures and estimated class-specific response probabilities of the five investigated models for deciding the number of classes (n = 9204)

Number of classes	Goodness-of-fit measures			Estimated class-specific response probabilities				
	Entropy	BIC	VLMR	Class 1	Class 2	Class 3	Class 4	Class 5
1	-	53267	-	1.000				
2	0.634	51685	p < .001*	0.855	0.895			
3	0.737	51556	p = .018*	0.814	0.780	0.935		
4	**0.723**	**51513**	**p = .007***	**0.884**	**0.833**	**0.910**	**0.803**	
5	0.734	51535	p = .384	0.889	0.904	0.778	0.841	0.860

Note. BIC = Bayesian Information Criterion, VLMR = Vuong-Lo-Mendell-Rubin adjusted Likelihood-Ratio-Test, * p < .05.

Figure 1 presents the estimated class-specific response probabilities, which are showing the patterns of multiple lifestyle risk factors among the four classes.

Figure 1

Class 1 (58.5 %) was characterised by individuals with near-zero probabilities for most of the lifestyle risk factors, except low physical activity and unhealthy diet. In comparison to the other classes, class 1 can be characterised as the healthy lifestyle class.

Class 2 accounted for one fourth of the sample (24.4 %) and included individuals with high probabilities for risky alcohol consumption, episodic heavy drinking, low physical activity and unhealthy diet as well as moderate probabilities of daily smoking. Class 2 can thus be described as showing a risky drinking lifestyle. Compared with the healthy lifestyle class, individuals in class 2 were more likely to be younger, male and single as well as having an average education and a German

citizenship (Table 3). Furthermore, individuals in the drinking lifestyle class were more likely to report symptoms of depression (Table 4).

Class 3 (15.4 %) was characterised by individuals with high probabilities for daily smoking and for showing low physical activity and unhealthy diet. Therefore, class 3 was labeled as smoking lifestyle class. Compared with the healthy lifestyle class, individuals in class 3 were more likely to be single or divorced as well as having a lower education (Table 3). Moreover, the smoking lifestyle class included more individuals who reported symptoms of specific phobia, depression or mania and good physical health (Table 4).

The smallest class (1.7 %) showed high probabilities for the use of tobacco, alcohol, cannabis and other illicit drugs as well as for episodic heavy drinking, low physical activity and unhealthy diet. Class 4 can be described as showing a polysubstance use lifestyle. Compared with the healthy lifestyle class, individuals in class 4 were more likely to be younger, male and single (Table 3). Additionally, individuals in the polysubstance use lifestyle class were more likely to report symptoms of mania and fear of public places (Table 4).

Table 3

Risk ratios (RR) und 95%-confidence intervals (CI) for sociodemographic factors associated with lifestyle risk factor classes

Variable		**Class 1**	**Class 2**		**Class 3**		**Class 4**	
		Healthy lifestyle	***Drinking lifestyle***		***Smoking lifestyle***		***Polysubstance use lifestyle***	
		(Reference)	RR	95%-CI	RR	95%-CI	RR	95%-CI
Gender	Male		1	1	1	1	1	1
	Female		0.30**	[0.26;0.34]	0.82	[0.67;1.00]	0.24**	[0.14;0.41]
Age	Age		0.98**	[0.97;0.98]	1.01	[1.00;1.01]	0.94**	[0.92;0.97]
Education	ISCED 1		1	1	1	1	1	1
	ISCED 2		1.34*	[1.06;1.69]	0.89	[0.63;1.26]	0.67	[0.35;1.27]
	ISCED 3		1.24	[0.96;1.61]	0.57*	[0.39;0.82]	0.58	[0.28;1.22]
Citizenship	German		1	1	1	1	1	1
	Other		0.69*	[0.51;0.92]	1.08	[0.73;1.61]	0.19	[0.02;1.43]
Region	West		1	1	1	1	1	1
	East		0.90	[0.76;1.07]	1.08	[0.87;1.34]	0.65	[0.36;1.20]
Marital status	Single		1	1	1	1	1	1
	Married		0.79*	[0.66;0.94]	0.79*	[0.63;0.99]	0.24*	[0.10;0.63]
	Widowed		0.23*	[0.10;0.55]	0.77	[0.38;1.54]	-	
	Divorced		1.04	[0.73;1.48]	1.52*	[1.04;2.22]	3.42	[1.09;10.75]

Note. The healthy lifestyle class was used as reference category. The results from the regression model are presented in two tables (table2 and table 3) for reasons of clarity and comprehensibility, but only one regression model was calculated. *p<0.05, **p<0.001, RR Risk Ratio, 95%-CI 95 % confidence interval. ISCED International Standard Classification of Education.

Table 4

Risk ratios (RR) und 95%-confidence intervals (CI) for self-rated physical health, neurological diseases, self-rated mental health and mental health problems associated with lifestyle risk factor classes.

Variable		**Class 1**	**Class 2**		**Class 3**		**Class 4**	
		Healthy lifestyle	***Drinking lifestyle***		***Smoking lifestyle***		***Polysubstance use lifestyle***	
		(Reference)	RR	95%-CI	RR	95%-CI	RR	95%-CI
Physical health			0.99	[0.89;1.09]	1.19*	[1.03;1.38]	1.27	[0.85;1.88]
Neurological disease			0.75	[0.51;1.10]	0.94	[0.62;1.42]	1.04	[0.38;2.83]
Mental health			1.00	[0.90;1.10]	1.01	[0.87;1.18]	1.28	[0.88;1.85]
Mental health problems	Psychosomatic complaints		0.91	[0.73;1.13]	0.97	[0.73;1.28]	0.94	[0.43;2.04]
	Panic attacks		0.92	[0.74;1.15]	0.86	[0.66;1.13]	0.95	[0.49;1.85]
	Generalized Anxiety Disorder		1.04	[0.87;1.24]	0.98	[0.78;1.22]	1.00	[0.55;1.84]
	Social Phobia		0.94	[0.72;1.23]	0.91	[0.64;1.28]	1.32	[0.67;2.57]
	Fear of public places		1.01	[0.63;1.64]	1.27	[0.75;2.16]	2.96*	[1.09;8.06]
	Specific Phobia		1.01	[0.77;1.32]	1.38*	[1.03;1.85]	1.33	[0.59;3.02]
	Depression		1.28*	[1.09;1.51]	1.56**	[1.25;1.95]	1.77	[0.95;3.30]
	Mania		1.11	[0.82;1.50]	1.26	[0.88;1.79]	1.96*	[1.00;3.83]
	Trauma		1.15	[0.99;1.33]	1.41*	[1.11;1.79]	1.23	[0.69;2.21]
In treatment/diagnosed mental disorder			0.82	[0.63;1.07]	1.14	[0.84;1.53]	0.43	[0.17;1.05]

Note. The healthy lifestyle class was used as reference category. The results from the regression model are presented in two tables (table2 and table 3) for reasons of clarity and comprehensibility, but only one regression model was calculated. *p<0.05, **p<0.001, RR Risk Ratio, 95% CI 95 % confidence interval.

DISCUSSION

Patterns of lifestyle risk factors

Our study identified four classes of lifestyle risk factors in the German population which can be best described as a healthy lifestyle (58.5 %), a drinking lifestyle (24.4 %), a smoking lifestyle (15.4 %) and a polysubstance use lifestyle (1.7 %).

In a systematic review of multiple lifestyle risk factors, Noble and colleagues [7] reported that the majority of the respondents (81 %) in the included studies belonged to a healthy class. Furthermore, 33 % of the studies reported a class showing a drinking lifestyle [7]. In contrast to these studies, we found patterns of lifestyle risk factors which were not reported in previous literature so far. The smallest class was characterised by high probabilities for using all included legal and illicit substances (polysubstance use lifestyle class). To our knowledge, the consumption of illicit drugs has not been studied before in relation to a cluster analysis of multiple lifestyle risk factors for a nationally representative sample. Our results suggest including the consumption of illicit drugs in further analyses about multiple lifestyle risk factors in general adulthood and not constraining it to analyses in adolescence. Furthermore, two systematic reviews found a strong association between drinking and smoking [7, 27]. In the present study, individuals with a high probability for risky alcohol consumption and episodic heavy drinking also had a moderate probability for smoking on a daily basis (class 2). On the other side, individuals with a very high probability for smoking did not have a higher probability for showing risky alcohol consumption (class 3). For further cluster analyses of multiple lifestyle risk factors, it seems to be an asset to include episodic heavy drinking as well as risky alcohol consumption or alcohol misuse.

Although the results of the present study are consistent with two systematic reviews in some ways [7, 27] one should be careful by comparing the results. Previous studies about clustering of lifestyle risk factors used various definitions, measurements and cut off points for multiple health behaviour, different statistical methods and diverse samples [7, 27]. Identifications of classes of multiple lifestyle risk factors in a national population on the basis of latent class analysis as the present study has demonstrated have been limited in previous research.

Although the results displayed that more than half of the German population practiced a relatively healthy lifestyle regarding consumption of alcohol, tobacco or illicit drugs, even individuals in the healthy lifestyle class show low physical activity and unhealthy diet. Nonetheless, compared to the other classes, the risk for unhealthy diet was less pronounced for individuals with a healthy lifestyle. Although physical activity and nutrition were not distinctive, the structure of the final class solution

preserved if the two variables were not included (sensitivity analyses not shown). In contrast, other German studies found class solutions with differences in regard to physical activity and nutrition [11, 10]. A possible explanation for this might be that these studies used different definitions of physical activity and nutrition and also used a lower threshold for high physical activity. Schneider and colleagues [11] for example defined physical activity as being active for one hour per week within the last year.

Factors associated with multiple lifestyle risk factors

Men were more likely to be in the drinking lifestyle (24.4 %) or polysubstance use lifestyle class (1.7 %) compared with women. This is coherent with literature, which reports that men have a higher risk of morbidity and mortality, because of their higher prevalence of lifestyle risk factors in general [28]. In the ESA 2015, men were also more likely to consume tobacco, alcohol and cannabis than women [16]. It is well known that men also have a higher risk of mortality and morbidity compared to women, but prevention and health promotion strategies are currently more often provided for both genders or especially for women [28]. In the future, prevention and health promotion strategies should focus especially on men.

Younger people were also more likely to be in the drinking lifestyle or polysubstance use lifestyle class. Previous research showed inconsistent associations between age and multiple lifestyle risk factors. Some studies found no clear associations, whereas others also reported that younger individuals were more likely to show multiple lifestyle risk factors [7, 29]. It seems possible that there might be underlying factors which could not be controlled for in this study, but could have mediated the association between age and lifestyle risk factors, for example personality traits, household income, peer groups and social networks [30]. Those underlying factors should be included as moderators or mediators in analyses between age and lifestyle risk factors in the future.

Individuals who were single had a higher risk to have a drinking lifestyle, a smoking lifestyle or a polysubstance use lifestyle compared to married individuals. Social relationships can have an influence on health behaviour. Especially women tend to show a regulatory role in intimate relationships and organize favorable lifestyle behaviours, for example the preparation of a balanced diet [31, 32]. It should be noted that the term “single” in the present study also includes individuals who have an intimate relationship but are not married. Nevertheless, it can be expected that the differences between married and single individuals in regard to the lifestyle risk class can be attributed to individuals who are not in an intimate relationship. Drefahl and colleagues [33] argued that the socioeconomic status plays an important role in regard to health behaviour and marital

status. In his study cohabiters who were not married and possessed a high socioeconomic status had a lower risk for mortality than married couples [33]. Further research should investigate how intimate relationships in particular have an influence on lifestyle risk factors and if there might be more underlying factors explaining this association.

Additionally, in the present study people with a German citizenship were more likely to be in the drinking lifestyle class. A study by Strupf and colleagues [34] also reported differences among people with and without migration background considering alcohol consumption, but further research is needed to assess motives for episodic heavy drinking among various cultural groups.

Furthermore, education was also associated with lifestyle risk groups. Individuals with a lower education were more likely to have a smoking lifestyle, whereas individuals with a moderate education were more likely to have a drinking lifestyle. It is consistent to literature that smoking is associated with lower education [35, 36] and lifestyle risk groups which are including alcohol intake, are associated with higher education [7, 37]. Future research should address the question, if the educational level has an effect on the awareness of health-compromising effects regarding at risk alcohol consumption and smoking.

Associations between lifestyle risk groups and mental health

The present study also looked at associations between lifestyle risk classes and mental health problems, which has not been done before with a nationally representative sample in Germany. Compared with the healthy lifestyle class, individuals in the polysubstance use lifestyle class were more likely to report symptoms of fear of public places and mania. The National Academy of Science recently reported that there is a moderate statistical association between regular cannabis use and increased symptoms of mania (individuals with bipolar disorders) and social anxiety [38]. It also showed itself consistent to the scientific literature that individuals with a drinking lifestyle were likely to report symptoms of depression [18] and individuals with a smoking lifestyle were more likely to report symptoms of depression, trauma or specific phobia [17]. On the other side it is also possible that people with mental health problems are more likely to use legal or illicit substances for self-medication [39]. Since we investigated correlations and not causality, one should interpret these results carefully.

Limitations

One shortcoming of this study is that the ESA study design is not able to reach certain subgroups with increased rates of substance consumption i.e. homeless people or inmates [40]. A further risk of bias results from the data collection in the form of self-reports which are prone to social desirability bias

[21]. Additionally, the ESA 2015 was unfortunately not able to distinguish between the usage of prescribed and non-prescribed opioid and non-opioid pharmaceuticals within the last 30 days. Since the present study was a cross-sectional analysis, one cannot tell if individuals change between lifestyle risk groups over lifetime. In the future, research with longitudinal studies in regard to this topic is necessary as well as the investigation about which factors could lead to a change of health behaviour.

Conclusions

The study showed patterns of lifestyle risk factors regarding the use of alcohol, episodic heavy drinking, tobacco, cannabis, other illicit drugs, pharmaceuticals as well as nutrition and physical activity. Some of the associations between lifestyle risk factors are already well documented in the literature, which emphasizes the plausibility of the results that were found. However, the study also adds new contributions to the scientific community. Based on the outcomes, we recommend three practical implications for the German population:

1) Young and single men were more likely to have an alcohol or polysubstance use lifestyle. In the future, prevention and health promotion strategies should focus especially on men, since they also have a higher risk for morbidity and mortality in general [28].

2) Individuals with various mental health problems were more likely to show multiple lifestyle risk factors. Prevention and health promotion strategies should address the associations between multiple lifestyle risk factors and mental health problems. Additionally, professionals at the health-care sector should also look at multiple lifestyle risk factors in patients with probable mental health disorders.

3) The high probabilities for unhealthy diet and low physical activity emphasize the importance of the promotion of regular physical activity and healthy nutrition in wide sections of the German population through intervention and prevention measures.

Contributors

DP, LK and EG designed the study and supervised the process of data collection. JA, EG and DP were responsible for data cleaning and creating the final dataset. JA conducted the statistical analysis and wrote the manuscript. DP and CA played a major role for developing the final outline for analyzing the data. All authors contributed to and have approved the final manuscript.

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Competing Interests:

LK and DP declare having received a grant from Lundbeck GmbH for a research project on alcohol epidemiology not related to this study. JA, CA and EG declare having no conflict of interest.

Data sharing statement

For scientific purposes it is possible to use the raw data of the Epidemiological Survey of Substance Abuse. All datasets (since 1980) are archived at GESIS Leibniz Institute for Social Research and can be requested there.

What is already known to this subject?

- Multiple lifestyle risk factors are more detrimental to health compared with single lifestyle risk factors
- German studies have solely examined patterns of multiple risk factors for subsamples (i.e. job-seekers, elders), which are not representative for the general population
- The identification of clusters based on lifestyle risk factors might facilitate the development of specific health promotion strategies for different vulnerable population groups

What this study adds?

- The present study is the first of its kind in this research area which also included the consumption of pharmaceuticals and illicit drugs into the latent class analysis.
- The results of the latent class analysis included a polysubstance class with high probabilities for consuming tobacco and illicit drugs, showing risky alcohol consumption and episodic heavy drinking, which speaks for including the consumption of illicit drugs in future analyses about multiple lifestyle risk factors.
- Compared to a healthy lifestyle, younger and single men were more likely to have an alcohol or polysubstance use lifestyle
- Individuals with various mental health problems were more likely to show multiple lifestyle risk factors

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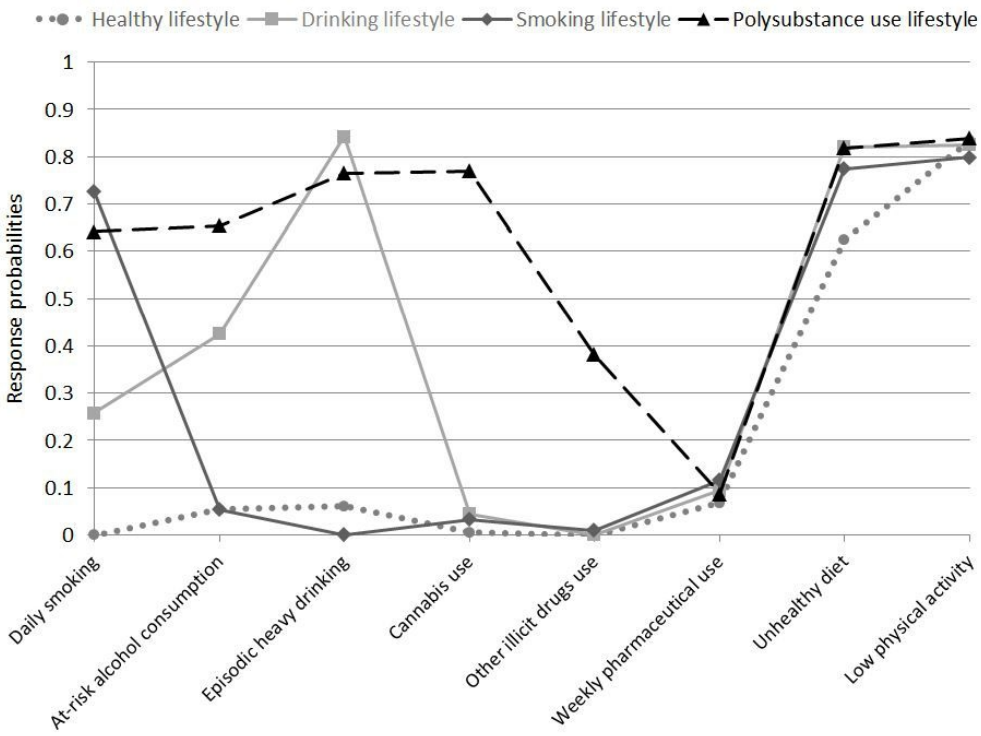
LEGEND

Figure 1. Estimated class-specific response probabilities for eight lifestyle risk factors.

Note. A high score indicates a high probability of showing a lifestyle risk factor



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Patterns of multiple lifestyle risk factors and their link to mental health: a latent class analysis in the German adult population

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ABSTRACT

Objectives: Lifestyle risk factors, such as drinking or unhealthy diet can expotentiate detrimental health effects. Therefore, it is important to investigate multiple lifestyle risk factors instead of single ones. The study aims at 1) identifying patterns of lifestyle risk factors within the adult general population in Germany, and at 2) examining associations between the extracted patterns and external factors.

Design: Cross-sectional study

Setting: General German adult population (aged 18 – 64 years).

Participants: Participants of the 2015 Epidemiological Survey of Substance Abuse (ESA) (n = 9204).

Primary outcome measures: Lifestyle risk factors (daily smoking, at risk alcohol consumption, unhealthy diet, low physical activity, weekly use of pharmaceuticals, as well as consumption of cannabis and other illicit drugs).

Results: A latent class analysis was applied to identify patterns of lifestyle risk factors and a multinomial logistic regression was carried out to examine associations between the extracted classes and external factors. A total of four classes were extracted which can be described as healthy lifestyle (58.5 %), drinking lifestyle (24.4 %), smoking lifestyle (15.4 %), and a cumulate risk factors lifestyle (1.7 %). Individuals who were male, at younger age and single as well as individuals with various mental health problems were more likely to show multiple lifestyle risk factors.

Conclusions: Health-care professionals should be aware of correlations between different lifestyle risk factors as well as between lifestyle risk groups and mental health. Health promotion strategies should further focus especially on younger and single men.

Keywords: epidemiology, health behaviour, lifestyle, mental health, population survey

STRENGTHS AND LIMITATIONS OF THIS STUDY

- First study about multiple lifestyle risk factors in the general German adult population using national representative data
- We conducted a latent class analysis including the usage of illicit drugs and pharmaceuticals as lifestyle risk factors, which has been rarely done before
- We assessed associations between lifestyle risk groups and external factors such as mental health, physical health, and sociodemographic factors
- The study design of the ESA is not able to reach certain subgroups with increased rates of substance consumption i.e. homeless people or inmates

INTRODUCTION

Lifestyle risk factors, like unhealthy diet, low physical activity as well as the consumption of legal and illicit substances are related to the development of several noncommunicable diseases such as cancer and cardiovascular diseases [1, 2]. In 2012, noncommunicable diseases accounted for 68% (n = 38.0 million) of deaths worldwide [3]. Therefore, lifestyle risk factors entail significant costs for a society and its economy. Germany's economic costs due to drinking and smoking are estimated at about 26 – 79 billion euro per year, respectively [4, 5].

Previous literature shows that lifestyle risk factors are associated with each other [6, 7]. Due to the fact that multiple lifestyle risk factors are more detrimental to health compared with single lifestyle risk factors [8, 9], the identification of risk classes might facilitate the development of specific health promotion strategies for different vulnerable population groups. Two German studies examined patterns of health behaviour in a sample of job-seekers [10] and in an older (50 years and more) population [11]. For example, Schneider and colleagues [11] identified five different classes: a class with no risk behaviour (25.3 %), a class with drinkers (22.7 %), a physically inactive class (21.1 %), a class with fruit and vegetable avoiders (18.2 %) and a class with smokers (12.7 %). In contrast, Schnuerer and colleagues [10] revealed three classes (substance use, non-exercising overweight, health-conscious).

Neither Schnuerer [10] nor Schneider [11] included illicit drugs in their analyses, although associations between cannabis and other substances, like alcohol, tobacco or pharmaceuticals, are often addressed in the scientific literature [12, 13, 14, 15]. In the 2015 German Epidemiological Survey of Substance Abuse (ESA 2015), analgesics were the most commonly used substance after alcohol in Germany [16]. Furthermore, with a prevalence of 7.4%, cannabis was the most widely used illicit drug in the last 12 months. Given that, it seems both timely and useful that these substances are taken into account for the examination of certain patterns of lifestyle risk factors.

Classes with high prevalence rates for lifestyle risk factors are associated with younger age, male gender, lower levels of education [7] and mental disorders (e.g. major depression) [17, 18]. Additionally, lifestyle risk factors are associated with self-rated health. For instance, a positive state of health seems to be correlated with low to zero consumption of alcohol and tobacco as well as with healthy nutrition and high physical activity [19, 20].

Evidence on the link between multiple lifestyle risk factors, mental disorders and self-rated health which is representative of the general population is currently not available for Germany. The first aim of this study was to assess patterns of multiple lifestyle risk factors (smoking, alcohol consumption, unhealthy diet, low physical activity, consumption of cannabis and other illicit drugs, use of

pharmaceuticals) in a nationwide sample in Germany. Secondly, the study examined if the extracted lifestyle patterns were associated with external factors like sociodemographic factors, self-related health, and mental health problems.

METHODS

Sample and procedure

The present study is based on data from the 2015 Epidemiological Survey of Substance Abuse (ESA 2015). The ESA is a population-representative cross-sectional survey assessing substance use among the general population in Germany [21] and has been conducted at regular intervals since the 1980s by the IFT Institut für Therapieforschung in Munich, Germany. The adjusted sample (weighted for region, age, gender and education) comprised 9,204 persons aged 18 to 64 years. The sample was drawn by means of a random two-stage selection procedure. At the first stage, 254 sample points (cities, communities) were drawn. Afterwards, the target population was randomly chosen from the sample points' population registers. Paper-and-pencil, telephone and internet-based methods were used to collect the data (net response rate = 52.2%). Overall, 5090 women (49.6%) and 4114 men (50.4%) with an average age of 38.3 years (SD = 14.7) participated in this study. The ESA was approved by the ethics committee of the German Psychological Society (DGPs; Reg.-No: GBLK06102008DGPS). A detailed description of methodology and design of the ESA 2015 can be found in Piontek and colleagues [21].

Participant involvement

Participants were not involved in the development of the study design or outcome measures. Participation was voluntary and could be terminated at any time. All data was used strictly confidentially and anonymously.

Selected variables for LCA (lifestyle risk factors)

To assess patterns of multiple lifestyle risk factors, eight variables were selected: smoking, alcohol consumption, episodic heavy drinking, diet, physical activity as well as the consumption of cannabis, other illicit drugs, and pharmaceuticals (analgesics, hypnotics or tranquilizer). All variables were dichotomized (0/1), and assessed whether respondents showed lifestyle risk factors (coded "1") or favorable lifestyle behaviours (coded "0").

Risky tobacco consumption was defined as daily smoking of at least one cigarette, cigar, pipe or cigarillo within the last 30 days. Alcohol consumption was measured using a quantity-frequency-index. The daily consumption of 12 grams (women) or 24 grams (men) of pure alcohol within the last

30 days was characterised as risky alcohol consumption. Episodic heavy drinking (EHD) was defined as consumption of five or more drinks of alcohol consumed on a single day for at least one time within the last 30 days. The consumption of cannabis and other illicit drugs (amphetamines, ecstasy, LSD, heroin and other opioids, cocaine, crack, mushrooms) as well as the weekly consumption of non-prescribed analgesics, hypnotics or tranquilizers within the last 30 days were defined as lifestyle risk factors. Analgesics included opioid as well as non-opioid drugs.

The rationale for lifestyle risk factors considering physical activity and nutrition was based on guidelines [22, 23]. For assessing physical activity, participants were asked on how many days per week they had been breathless and sweated because of physical activity within the last three months. Participants, who were physically active for at least one day per week, were asked about the average duration of physical activity. The question could be answered on an ordinal scale (1 “Less than 10 minutes”, 2 “10 to less than 30 minutes”, 3 “30 to 60 minutes”, 4 “More than 60 minutes”).Based on the questions about frequency and duration of physical activity, a dichotomous variable was generated approximately fulfilling the recommendations of the American College of Sports Medicine and the American Heart Association [23]. Thus, physical activity for less than 30 min per day on five days per week was classified as lifestyle risk factor. Diet was assessed using a validated food frequency questionnaire (LML-6) of six items, asking how often somebody would eat low fat milk products, crudités, fresh salads, fresh herbs, fresh fruits and cereal products. The response categories ranged from 1 (rarely or never) to 5 (several times a day). A nutrition index was calculated [22] whereby a low index score (< 10) corresponded to an unhealthy diet indicating a lifestyle risk factor.

Selected variables for associations with extracted classes (predictors)

The following variables were selected to examine the association of the health lifestyle classes with external factors: sociodemographic factors, self-rated physical health (1 very good – 5 very bad), self-rated mental health (1 very good – 5 very bad), neurological diseases (no/yes), and a broad range of mental health problems within the last 12 months (i.e. depression).

To screen for mental health problems in the past 12 months, screening questions of the following sections of the Munich Composite Diagnostic International Interview (M-CIDI) [24] were used: panic attacks, general anxiety, social phobia, anxiety of public places, specific phobia, depression, mania and post-traumatic stress disorder (PTSD). Furthermore, the respondents were asked whether they were in treatment for mental health problems or had been diagnosed with a mental disorder. All variables were dichotomized (no/yes).

Sociodemographic information was assessed by questions on gender (male, female), age (18 – 64 years), marital status (single, married, divorced, widowed) and education (low, average, high). Education was categorized into three groups according to the International Standard Classification of Education (ISCED) [25].

Data analysis

A latent class analysis (LCA) was performed on eight categorical lifestyle risk factors as described above. The LCA is a probabilistic model which identifies mutually exclusive classes (risk groups) of a non-directly measurable variable. The LCA calculates the probability that a particular person belongs to a certain (latent) class as well as the probability that an individual in a certain class will give a particular answer [26]. These probabilities are known as unconditional class membership probability and class-specific response probability. The exact number of classes of the latent variable is notspecified by the LCA. Goodness-of-fit measures (Bayesian Information Criterion (BIC), Entropy, Vuong-Lo-Mendell-Rubin adjusted Likelihood-Ratio-test (VLMR)) were used to select the best model. A low BIC, high Entropy and a significant VLMR indicate the best class-solution, but the final decision was also based on the researchers' assessment of the interpretability of the results [27]. We tested models with up to five classes. Since the sample of the ESA 2015 was drawn by a two-stage selection procedure, individuals were only selected at random within each sample point. The complex sampling of the ESA data required using a complex mixture term, since the results would be biased otherwise. Furthermore, all data was weighted (gender, age, region, and education) in order to provide results which are representative for the general adult population in Germany. The LCA was performed in MPlus using maximum likelihood estimation with robust standard errors [28].

The conditional class membership probabilities were further used for a multinomial logistic regression [29] testing for associations of the classes with external factors (e.g. sociodemographic factors, mental health problems) as described above (listwise deletion of missing data). Classes were used as outcome variables and all predictors were included at once. Control variables were region, citizenship and mode of interview (paper-and-pencil, telephone, internet-based). The class with individuals showing mostly a healthy lifestyle class was used as reference category. Risk ratios as well as 95%-confidence intervals were calculated while using sampling weights and the svyset command to adjust for the complex sample design. There was no sign of multicollinearity among the independent variables. The regression model was run in STATA 12.1 SE [30].

RESULTS

Respondent characteristics

In total, low physical activity (82.6 %) and unhealthy diet (69.9 %) were the two most prevalent lifestyle risk factors (Table 1). The lowest prevalence rates were reported for the use of illicit drugs (0.8 %) and the use of cannabis (3.1%). About one quarter of the respondents reported episodic heavy drinking and one fifth reported daily smoking.

Table 1

Weighted prevalence rates for lifestyle risk factors (n = 9204)

Risk factors	Total		
	n	%	95%-CI
Daily Smoking	1322	18.5	[17.3,19.8]
At-risk drinking	1416	15.3	[14.4,16.3]
Episodic heavy drinking	2513	25.3	[24.0,26.7]
Cannabis use	386	3.1	[2.7,3.6]
Other illicit drugs use	75	0.8	[0.6,1.1]
Weekly pharmaceuticals use	733	8.2	[7.5,8.9]
Unhealthy diet	6185	69.9	[68.8,71.0]
Low physical activity	6423	82.6	[81.5,83.7]

Note. n = observed frequency of lifestyle risk factors, % = prevalence rates, 95%-CI = confidence intervals; weighted for age, region, gender and education.

Latent class analysis and class profiles

Latent class models with one to five classes were estimated. Although the Entropy indicated a 3-class solution, the 4-class solution was selected as the final model due to better values of BIC, VLMR and the estimated class-specific response probabilities (> 0.8) (Table 2). Residual-based goodness-of-fit (standardized z-scores) showed only minor violations (> 1.96) of the assumption of local independence in all classes (data not shown) and therefore did not affect the selection of the final model.

Table 2

Goodness-of-fit measures and estimated class-specific response probabilities of the five investigated models for deciding the number of classes (n = 9204)

Number of classes	Goodness-of-fit measures			Estimated class-specific response probabilities				
	Entropy	BIC	VLMR	Class 1	Class 2	Class 3	Class 4	Class 5
1	-	53267	-	1.000				
2	0.634	51685	p < .001*	0.855	0.895			
3	0.737	51556	p = .018*	0.814	0.780	0.935		
4	**0.723**	**51513**	**p = .007***	**0.884**	**0.833**	**0.910**	**0.803**	
5	0.734	51535	p = .384	0.889	0.904	0.778	0.841	0.860

Note. BIC = Bayesian Information Criterion, VLMR = Vuong-Lo-Mendell-Rubin adjusted Likelihood-Ratio-Test, * p < .05.

Figure 1 presents the estimated class-specific response probabilities, which are showing the patterns of multiple lifestyle risk factors among the four classes.

Figure 1

Class 1 (58.5 %) was characterised by individuals with near-zero probabilities for most of the lifestyle risk factors, except low physical activity and unhealthy diet. In comparison to the other classes, class 1 can be characterised as the healthy lifestyle class.

Class 2 accounted for one fourth of the sample (24.4 %) and included individuals with high probabilities for risky alcohol consumption, episodic heavy drinking, low physical activity and unhealthy diet as well as moderate probabilities of daily smoking. Class 2 can be described as showing a risky drinking lifestyle. Compared with the healthy lifestyle class, individuals in class 2 were more likely to be younger, male and single as well as having an average education and a German citizenship (Table 3). Furthermore, individuals in the drinking lifestyle class were more likely to report symptoms of depression or PTSD (Table 4).

Class 3 (15.4 %) was characterised by individuals with high probabilities for daily smoking and for showing low physical activity and unhealthy diet. Class 3 was labeled as smoking lifestyle class. Compared with the healthy lifestyle class, individuals in class 3 were more likely to be single or divorced as well as having a lower education (Table 3). Moreover, the smoking lifestyle class included

more individuals who reported symptoms of specific phobia, depression or PTSD as well as bad physical health (Table 4).

The smallest class (1.7 %) showed high probabilities for the use of tobacco, alcohol, cannabis and other illicit drugs as well as for episodic heavy drinking, low physical activity and unhealthy diet. Class 4 can be described as showing a cumulate risk factors lifestyle. Compared with the healthy lifestyle class, individuals in class 4 were more likely to be younger, male,single or divorced (Table 3). Additionally, individuals in the cumulate risk factors lifestyle class were more likely to report symptoms of fear of public places (Table 4).

Table 3

Risk ratios (RR) and 95%-confidence intervals (CI) for sociodemographic factors associated with lifestyle risk factor classes

Variable		**Class 1** ***Healthy lifestyle*** *(Reference)*	**Class 2** ***Drinking lifestyle*** RR	95%-CI	**Class 3** ***Smoking lifestyle*** RR	95%-CI	**Class 4** ***Cumulate risk factors lifestyle*** RR	95%-CI
Gender	Male		1	1	1	1	1	1
	Female		0.30**	[0.26;0.34]	0.82	[0.67;1.00]	0.24**	[0.14;0.41]
Age	Age		0.98**	[0.97;0.98]	1.01	[1.00;1.01]	0.94**	[0.92;0.97]
Education	ISCED 1		1	1	1	1	1	1
	ISCED 2		1.39*	[1.10;1.75]	1.01	[0.71;1.42]	0.72	[0.37;1.38]
	ISCED 3		1.15	[0.89;1.49]	0.47**	[0.33;0.67]	0.54	[0.28;1.07]
Citizenship	German		1	1	1	1	1	1
	Other		0.72*	[0.54;0.95]	1.12	[0.75;1.66]	0.27	[0.06;1.28]
Region	West		1	1	1	1	1	1
	East		0.91	[0.76;1.09]	1.09	[0.87;1.35]	0.69	[0.37;1.28]
Marital status	Single		1	1	1	1	1	1
	Married		0.79*	[0.66;0.94]	0.79*	[0.62;0.99]	0.24*	[0.09;0.62]
	Widowed		0.23*	[0.10;0.55]	0.74	[0.37;1.48]	-	
	Divorced		1.03	[0.73;1.48]	1.51*	[1.04;2.21]	3.37*	[1.08;10.56]

Note. The healthy lifestyle class was used as reference category. The results from the regression model are presented in two tables (table 2 and table 3) for reasons of clarity and comprehensibility, but only one regression model was calculated. *p<0.05, **p<0.001, RR Risk Ratio, 95%-CI 95 % confidence interval. ISCED International Standard Classification of Education.

Table 4

Risk ratios (RR) and 95%-confidence intervals (CI) for self-rated physical health, neurological diseases, self-rated mental health and mental health problems associated with lifestyle risk factor classes.

Variable		**Class 1** ***Healthy lifestyle*** *(Reference)*	**Class 2** ***Drinking lifestyle*** RR	95%-CI	**Class 3** ***Smoking lifestyle*** RR	95%-CI	**Class 4** ***Cumulate risk factors lifestyle*** RR	95%-CI
Physical health			0.99	[0.89;1.09]	1.17*	[1.01;1.36]	1.26	[0.85;1.87]
Neurological disease			0.74	[0.50;1.09]	0.93	[0.61;1.41]	1.03	[0.38;2.80]
Mental health			0.99	[0.90;1.09]	1.01	[0.87;1.18]	1.28	[0.88;1.84]
Mental health problems	Psychosomatic complaints		0.91	[0.73;1.13]	0.97	[0.73;1.29]	0.94	[0.43;2.03]
	Panic attacks		0.91	[0.73;1.14]	0.84	[0.64;1.11]	0.92	[0.47;1.80]
	Generalized Anxiety Disorder		1.05	[0.88;1.25]	0.98	[0.79;1.23]	1.02	[0.56;1.88]
	Social Phobia		0.94	[0.72;1.23]	0.89	[0.63;1.26]	1.37	[0.71;2.62]
	Fear of public places		1.01	[0.62;1.63]	1.26	[0.74;2.14]	2.86*	[1.06;7.71]
	Specific Phobia		1.00	[0.77;1.31]	1.36*	[1.02;1.81]	1.33	[0.59;3.00]
	Depression		1.28*	[1.09;1.51]	1.56**	[1.25;1.94]	1.79	[0.96;3.31]
	Mania		1.12	[0.83;1.51]	1.24	[0.87;1.77]	1.93	[0.98;3.78]
	PTSD		1.17*	[1.01;1.35]	1.44*	[1.13;1.83]	1.23	[0.69;2.19]
In treatment/diagnosed mental disorder			0.81	[0.62;1.06]	1.15	[0.85;1.55]	0.42	[0.17;1.04]

Note. The healthy lifestyle class was used as reference category. The results from the regression model are presented in two tables (table2 and table 3) for reasons of clarity and comprehensibility, but only one regression model was calculated. *p<0.05, **p<0.001, RR Risk Ratio, 95% CI 95 % confidence interval.

DISCUSSION

Patterns of lifestyle risk factors

Our study identified four classes of lifestyle risk factors in the German population which can be best described as a healthy lifestyle (58.5 %), a drinking lifestyle (24.4 %), a smoking lifestyle (15.4 %) and a cumulate risk factors lifestyle (1.7 %).

In a systematic review of multiple lifestyle risk factors, Noble and colleagues [7] reported that the majority of the respondents (81 %) in the included studies belonged to a class, which did not show any lifestyle risk factors. Furthermore, 33 % of the studies reported a class showing a drinking lifestyle [7]. In contrast to these studies, we found patterns of lifestyle risk factors which were not reported in previous literature so far. The smallest class was characterised by high probabilities for using all included legal and illicit substances (cumulate risk factors lifestyle). To our knowledge, the consumption of illicit drugs has not been studied before in relation to a class analysis of multiple lifestyle risk factors in a nationally representative sample. Our results suggest including the consumption of illicit drugs in further analyses about multiple lifestyle risk factors in general adulthood and not constraining it to analyses in adolescence. Furthermore, two systematic reviews found a strong association between drinking and smoking [7, 31]. In the present study, individuals with a high probability for risky alcohol consumption and episodic heavy drinking also had a moderate probability for smoking on a daily basis (class 2). On the other side, individuals with a very high probability for smoking did not have a higher probability for showing risky alcohol consumption (class 3). For further class analyses of multiple lifestyle risk factors, it seems to be an asset to include episodic heavy drinking as well as risky alcohol consumption or alcohol misuse.

Although the results of the present study are consistent with two systematic reviews in some ways [31, 7] one should be careful by comparing the results. Previous studies classifying lifestyle risk factors used various definitions, measurements and cut off points for multiple health behaviour, different statistical methods and diverse samples [31, 7]. Identifications of classes of multiple lifestyle risk factors in a national population on the basis of latent class analysis as the present study has demonstrated have been limited in previous research.

Although the results indicated that more than half of the German population practiced a relatively healthy lifestyle regarding consumption of alcohol, tobacco or illicit drugs, even individuals in the healthy lifestyle class showed low physical activity and unhealthy diet. Nonetheless, compared to the other classes, the risk for unhealthy diet was less pronounced for individuals with a healthy lifestyle. Although physical activity and nutrition were not distinctive, the structure of the final class solution

preserved if the two variables were not included (sensitivity analyses not shown). In contrast, other German studies found class solutions with differences in regard to physical activity and nutrition [11, 10]. A possible explanation for this might be that these studies used different definitions of physical activity and nutrition and also used a lower threshold for high physical activity. Schneider and colleagues [11] for example defined physical activity as being active for one hour per week within the last year. In addition, the ESA 2015 was only able to assess moderate-intensive physical activity and not vigorous-intensive physical activity, which could have led to an underestimation of physical activity in the sample. As a consequence, the questions for assessing physical activity have been completely revised for future assessments in ESA. Furthermore, nutrition was assessed with a food frequency questionnaire (LML-6) consisting of six items due to limited space [22]. Even though the LML-6 was validated, a different questionnaire with more items could have assessed nutrition and unhealthy diet more precisely.

Factors associated with multiple lifestyle risk factors

Men were more likely to be in the drinking lifestyle (24.4 %) or cumulate risk factors lifestyle class (1.7 %) compared with women. This is coherent with literature, which reports that men have a higher risk of morbidity and mortality, because of their higher prevalence of lifestyle risk factors in general [32]. In the ESA study, men were also more likely to consume tobacco, alcohol and cannabis than women [16]. It is well known that men also have a higher risk of mortality and morbidity compared to women, but prevention and health promotion strategies are currently more often provided for both genders or especially for women [32]. In the future, prevention and health promotion strategies should focus especially on men.

Younger people were also more likely to be in the drinking lifestyle or cumulate risk factors lifestyle class. Previous research showed inconsistent associations between age and multiple lifestyle risk factors. Some studies found no clear associations, whereas others also reported that younger individuals were more likely to show multiple lifestyle risk factors [7, 33]. It seems possible that there might be underlying factors which could not be controlled for in this study, but could have mediated the association between age and lifestyle risk factors, for example personality traits, household income, peer groups and social networks [34]. Those underlying factors should be included as moderators or mediators in analyses between age and lifestyle risk factors in the future.

Individuals who were single had a higher risk to have a drinking lifestyle, a smoking lifestyle or cumulate risk factors lifestyle compared to married individuals. Social relationships can have an influence on health behaviour. Especially women tend to show a regulatory role in intimate

relationships and organize favorable lifestyle behaviours, for example the preparation of a balanced diet [35, 36]. It should be noted that the term “single” in the present study also includes individuals who have an intimate relationship but are not married. Nevertheless, it can be expected that the differences between married and single individuals in regard to the lifestyle risk class can be attributed to individuals who are not in an intimate relationship. Drefahl and colleagues [37] argued that the socioeconomic status plays an important role in regard to health behaviour and marital status. In his study cohabiters who were not married and possessed a high socioeconomic status had a lower risk for mortality than married couples [37]. Further research should investigate how intimate relationships in particular have an influence on lifestyle risk factors and if there might be more underlying factors explaining this association.

Additionally, in the present study people with a German citizenship were more likely to be in the drinking lifestyle class. A study by Strupf and colleagues [38] also reported differences among people with and without migration background considering alcohol consumption, but further research is needed to assess motives for episodic heavy drinking among various cultural groups.

Furthermore, education was also associated with lifestyle risk groups. Individuals with a lower education were more likely to have a smoking lifestyle, whereas individuals with a moderate education were more likely to have a drinking lifestyle. It is consistent to literature that smoking is associated with lower education [39, 40] and lifestyle risk groups which are including alcohol intake, are associated with higher education [7, 41]. Future research should address the question, if the educational level has an effect on the awareness of health-compromising effects regarding at risk alcohol consumption and smoking.

Associations between lifestyle risk groups and mental health

The present study also looked at associations between lifestyle risk classes and mental health problems, which has not been done before with a nationally representative sample in Germany. Compared with the healthy lifestyle class, individuals in the cumulate risk factors lifestyle class were more likely to report symptoms of fear of public places. The National Academy of Science recently reported that there is a moderate statistical association between regular cannabis use and increased symptoms of social anxiety [42]. Also consistent with the scientific literature were the findings that individuals with a drinking lifestyle were likely to report symptoms of depression [18] and that individuals with a smoking lifestyle were more likely to report symptoms of depression, PTSD or specific phobia [17]. On the other side it is also possible that people with mental health problems are

more likely to use legal or illicit substances for self-medication [43]. Since we investigated correlations and not causality, these results should be interpreted with caution.

Limitations

One shortcoming of this study is that the ESA study design does not reach certain subgroups with increased rates of substance consumption, i.e. homeless people or inmates [44]. A further risk of bias results from the data collection in the form of self-reports which are prone to social desirability bias [21]. Unfortunately, the ESA 2015 *data collection did not* distinguish between the usage of non-prescribed opioid and non-opioid pharmaceuticals within the last 30 days. Furthermore, it was not assessed if participants had misused prescribed pharmaceuticals. Since the present study was a cross-sectional analysis, one cannot tell if individuals change between lifestyle risk groups over lifetime. In the future, research with longitudinal studies in regard to this topic is necessary as well as the investigation which factors could lead to a change of health behaviour.

Despite these limitations, the ESA provides a large sample and a good response rate [21]. Furthermore, based on the use of different modes of administration and weighting procedures, the ESA provides representative estimates for lifestyle risk factors in the general adult population in Germany.

Conclusions

The study showed patterns of lifestyle risk factors regarding the use of alcohol, episodic heavy drinking, tobacco, cannabis, other illicit drugs, pharmaceuticals as well as nutrition and physical activity. Some of the associations between lifestyle risk factors are already well documented in the literature, which emphasizes the plausibility of the results that were found. However, the study also adds new contributions to the scientific community. Based on the outcomes, we recommend three practical implications for the German population:

1) Young and single men were more likely to have an alcohol or cumulate risk factors lifestyle. In the future, prevention and health promotion strategies should focus especially on men, since they also have a higher risk for morbidity and mortality in general [32].

2) Individuals with various mental health problems were more likely to show multiple lifestyle risk factors. Prevention and health promotion strategies should address the associations between multiple lifestyle risk factors and mental health problems. Additionally, professionals at the health-care sector should also look at multiple lifestyle risk factors in patients with probable mental health disorders.

3) The high probabilities for unhealthy diet and low physical activity emphasize the importance of the promotion of regular physical activity and healthy nutrition in wide sections of the German population through intervention and prevention measures.

Contributors

DP, LK and EG designed the study and supervised the process of data collection. JA, EG and DP were responsible for data cleaning and creating the final dataset. JA conducted the statistical analysis and wrote the manuscript. DP and CA played a major role for developing the final outline for analyzing the data. All authors contributed to and have approved the final manuscript.

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Competing Interests:

LK and DP declare having received a grant from Lundbeck GmbH for a research project on alcohol epidemiology not related to this study. JA, CA and EG declare having no conflict of interest.

Data sharing statement

For scientific purposes it is possible to use the raw data of the Epidemiological Survey of Substance Abuse. All datasets (since 1980) are archived at GESIS Leibniz Institute for Social Research and can be requested there.

What is already known to this subject?

- Multiple lifestyle risk factors are more detrimental to health compared with single lifestyle risk factors
- German studies have solely examined patterns of multiple risk factors for subsamples (i.e. job-seekers, elders), which are not representative for the general population
- The identification of classes based on lifestyle risk factors might facilitate the development of specific health promotion strategies for different vulnerable population groups

What this study adds?

- The present study is the first of its kind in this research area which also included the consumption of pharmaceuticals and illicit drugs into the latent class analysis.
- The results of the latent class analysis included a cumulate risk factors lifestyle class with high probabilities for consuming tobacco and illicit drugs, showing risky alcohol consumption and episodic heavy drinking, which speaks for including the consumption of illicit drugs in future analyses about multiple lifestyle risk factors.
- Compared to a healthy lifestyle, younger and single men were more likely to have an alcohol or cumulate risk factors lifestyle
- Individuals with various mental health problems were more likely to show multiple lifestyle risk factors

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LEGEND

Figure 1. Estimated class-specific response probabilities for eight lifestyle risk factors.

Note. A high score indicates a high probability of showing a lifestyle risk factor

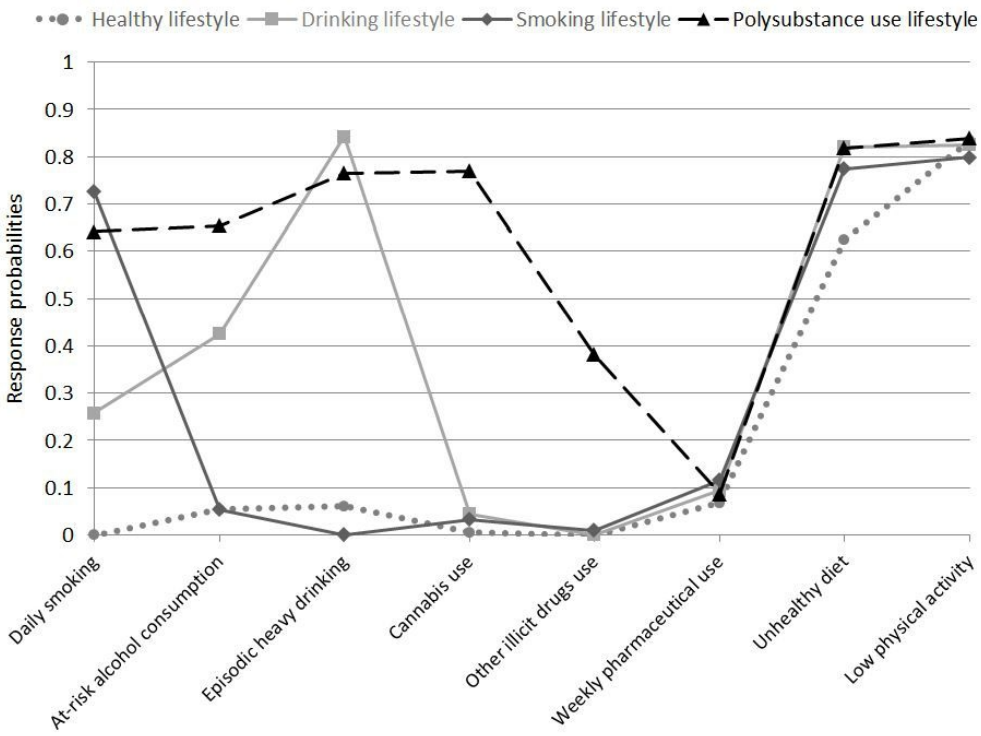

Figure 1. Estimated class-specific response probabilities for eight lifestyle risk factors. Note. A high score indicates a high probability of showing a lifestyle risk factor

77x57mm (300 x 300 DPI)

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Comments
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2	
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2	
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4	
Objectives	3	State specific objectives, including any prespecified hypotheses	4-5	
Methods				
Study design	4	Present key elements of study design early in the paper	5	
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5	A reference is cited with more detailed information of of methodology and design of the ESA 2015: Piontek D, Kraus L, Gomes De Matos E, Atzendorf J (2016) The 2015 Epidemiological Survey of Substance Abuse: Study Design and Methodology. Sucht 62:259-269.
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	/	A reference is cited with more detailed information of of methodology and design of the ESA 2015 Piontek D, Kraus L, Gomes De Matos E, Atzendorf J (2016) The 2015 Epidemiological

				Survey of Substance Abuse: Study Design and Methodology. Sucht 62:259-269.
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	/	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-7	
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	5-7	
Bias	9	Describe any efforts to address potential sources of bias	16	Methodological limitations are mentioned in the discussion section.
Study size	10	Explain how the study size was arrived at	5	A reference is cited with more detailed information of of methodology and design of the ESA 2015: Piontek D, Kraus L, Gomes De Matos E, Atzendorf J (2016) The 2015 Epidemiological Survey of Substance Abuse: Study Design and Methodology. Sucht 62:259-269.
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5-7	
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7	
		(*b*) Describe any methods used to examine subgroups and interactions	7	
		(*c*) Explain how missing data were addressed	7	
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed	/	A reference is cited with more

		Case-control study—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy		detailed information of of methodology and design of the ESA 2015: Piontek D, Kraus L, Gomes De Matos E, Atzendorf J (2016) The 2015 Epidemiological Survey of Substance Abuse: Study Design and Methodology. Sucht 62:259-269.
		(*e*) Describe any sensitivity analyses	14	The sensitivity analysis is not shown in the method section, because it is more relevant for the discussion.
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	/	A reference is cited with more detailed information of of methodology and design of the ESA 2015: Piontek D, Kraus L, Gomes De Matos E, Atzendorf J (2016) The 2015 Epidemiological Survey of Substance Abuse: Study Design and Methodology. Sucht 62:259-269.
		(b) Give reasons for non-participation at each stage		
		(c) Consider use of a flow diagram		
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	5, 8	
		(b) Indicate number of participants with missing data for each variable of interest		
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)		
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time		
		Case-control study—Report numbers in each exposure category, or summary measures of exposure		
		Cross-sectional study—Report numbers of outcome events or summary measures	8-12	

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	8, 11-12	The authors chose not to show unweighted percentages, since only the weighted percentages are representative for the general adult population in Germany.
		(*b*) Report category boundaries when continuous variables were categorized	/	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	/	

Continued on next page

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	18	Summarise key results with reference to study objectives
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
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21	Discuss the generalisability (external validity) of the study results
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

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

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.

BMJ Open

Patterns of multiple lifestyle risk factors and their link to mental health in the German adult population: a cross-sectional study

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Title:

Patterns of multiple lifestyle risk factors and their link to mental health in the German adult population: a cross-sectional study

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ABSTRACT

Objectives: Lifestyle risk factors, such as drinking or unhealthy diet can expotentiate detrimental health effects. Therefore, it is important to investigate multiple lifestyle risk factors instead of single ones. The study aims at 1) identifying patterns of lifestyle risk factors within the adult general population in Germany, and at 2) examining associations between the extracted patterns and external factors.

Design: Cross-sectional study

Setting: General German adult population (aged 18 – 64 years).

Participants: Participants of the 2015 Epidemiological Survey of Substance Abuse (ESA) (n = 9204).

Primary outcome measures: Lifestyle risk factors (daily smoking, at risk alcohol consumption, unhealthy diet, low physical activity, weekly use of pharmaceuticals, as well as consumption of cannabis and other illicit drugs).

Results: A latent class analysis was applied to identify patterns of lifestyle risk factors and a multinomial logistic regression was carried out to examine associations between the extracted classes and external factors. A total of four classes were extracted which can be described as healthy lifestyle (58.5 %), drinking lifestyle (24.4 %), smoking lifestyle (15.4 %), and a cumulate risk factors lifestyle (1.7 %). Individuals who were male, at younger age and single as well as individuals with various mental health problems were more likely to show multiple lifestyle risk factors.

Conclusions: Health-care professionals should be aware of correlations between different lifestyle risk factors as well as between lifestyle risk groups and mental health. Health promotion strategies should further focus especially on younger and single men.

Keywords: epidemiology, health behaviour, lifestyle, mental health, population survey, latent class analysis

STRENGTHS AND LIMITATIONS OF THIS STUDY

- First study about multiple lifestyle risk factors in the general German adult population using national representative data
- We conducted a latent class analysis including the usage of illicit drugs and pharmaceuticals as lifestyle risk factors, which has been rarely done before
- We assessed associations between lifestyle risk groups and external factors such as mental health, physical health, and sociodemographic factors
- The study design of the ESA is not able to reach certain subgroups with increased rates of substance consumption i.e. homeless people or inmates

INTRODUCTION

Lifestyle risk factors, like unhealthy diet, low physical activity as well as the consumption of legal and illicit substances are related to the development of several noncommunicable diseases such as cancer and cardiovascular diseases [1, 2]. In 2012, noncommunicable diseases accounted for 68% (n = 38.0 million) of deaths worldwide [3]. Therefore, lifestyle risk factors entail significant costs for a society and its economy. Germany's economic costs due to drinking and smoking are estimated at about 26 – 79 billion euro per year, respectively [4, 5].

Previous literature shows that lifestyle risk factors are associated with each other [6, 7]. Due to the fact that multiple lifestyle risk factors are more detrimental to health compared with single lifestyle risk factors [8, 9], the identification of risk classes might facilitate the development of specific health promotion strategies for different vulnerable population groups. Two German studies examined patterns of health behaviour in a sample of job-seekers [10] and in an older (50 years and more) population [11]. For example, Schneider and colleagues [11] identified five different classes: a class with no risk behaviour (25.3 %), a class with drinkers (22.7 %), a physically inactive class (21.1 %), a class with fruit and vegetable avoiders (18.2 %) and a class with smokers (12.7 %). In contrast, Schnuerer and colleagues [10] revealed three classes (substance use, non-exercising overweight, health-conscious).

Neither Schnuerer [10] nor Schneider [11] included illicit drugs in their analyses, although associations between cannabis and other substances, like alcohol, tobacco or pharmaceuticals, are often addressed in the scientific literature [12-15]. In the 2015 German Epidemiological Survey of Substance Abuse (ESA 2015), analgesics were the most commonly used substance after alcohol in Germany [16]. Furthermore, with a prevalence of 7.4%, cannabis was the most widely used illicit drug in the last 12 months. Given that, it seems both timely and useful that these substances are taken into account for the examination of certain patterns of lifestyle risk factors.

Classes with high prevalence rates for lifestyle risk factors are associated with younger age, male gender, lower levels of education [7] and mental disorders (e.g. major depression) [17, 18]. Additionally, lifestyle risk factors are associated with self-rated health. For instance, a positive state of health seems to be correlated with low to zero consumption of alcohol and tobacco as well as with healthy nutrition and high physical activity [19, 20].

Evidence on the link between multiple lifestyle risk factors, mental disorders and self-rated health which is representative of the general population is currently not available for Germany. The first aim of this study was to assess patterns of multiple lifestyle risk factors (smoking, alcohol consumption, unhealthy diet, low physical activity, consumption of cannabis and other illicit drugs, use of

pharmaceuticals) in a nationwide sample in Germany. Secondly, the study examined if the extracted lifestyle patterns were associated with external factors like sociodemographic factors, self-related health, and mental health problems.

METHODS

Sample and procedure

The present study is based on data from the 2015 Epidemiological Survey of Substance Abuse (ESA 2015). The ESA is a population-representative cross-sectional survey assessing substance use among the general population in Germany [21] and has been conducted at regular intervals since the 1980s by the IFT Institut für Therapieforschung in Munich, Germany. The adjusted sample comprised 9,204 persons aged 18 to 64 years. The sample was drawn by means of a random two-stage selection procedure. At the first stage, 254 sample points (cities, communities) were drawn. Afterwards, the target population was randomly chosen from the sample points' population registers. Paper-and-pencil, telephone and internet-based methods were used to collect the data (net response rate = 52.2%). Data was weighted using a redressement weight (age, gender, education, federal states and district size classes) based on the Iterative Proportional Fitting Algorithm [22]. The required marginal distributions of the population (18 to 64 years) were taken from the 2014 micro-census. The value of the redressement weight ranges between 0.19 and 5.63 (effectiveness 65.5% for n = 5,962) [21]. Overall, 5090 women (49.6%) and 4114 men (50.4%) with an average age of 38.3 years (SD = 14.7) participated in this study. The ESA was approved by the ethics committee of the German Psychological Society (DGPs; Reg.-No: GBLK06102008DGPS).

Participant involvement

Participants were not involved in the development of the study design or outcome measures. Participation was voluntary and could be terminated at any time. All data was used strictly confidentially and anonymously.

Selected variables for LCA (lifestyle risk factors)

To assess patterns of multiple lifestyle risk factors, eight variables were selected: smoking, alcohol consumption, episodic heavy drinking, diet, physical activity as well as the consumption of cannabis, other illicit drugs, and pharmaceuticals (analgesics, hypnotics or tranquilizer). All variables were dichotomized (0/1), and assessed whether respondents showed lifestyle risk factors (coded "1") or favorable lifestyle behaviours (coded "0").

Risky tobacco consumption was defined as daily smoking of at least one cigarette, cigar, pipe or cigarillo within the last 30 days. Alcohol consumption was measured using a quantity-frequency-index. The daily consumption of 12 grams (women) or 24 grams (men) of pure alcohol within the last 30 days was characterised as risky alcohol consumption. Episodic heavy drinking (EHD) was defined as consumption of five or more drinks of alcohol consumed on a single day for at least one time within the last 30 days. The consumption of cannabis and other illicit drugs (amphetamines, ecstasy, LSD, heroin and other opioids, cocaine, crack, mushrooms) as well as the weekly consumption of non-prescribed analgesics, hypnotics or tranquilizers within the last 30 days were defined as lifestyle risk factors. Analgesics included opioid as well as non-opioid drugs.

The rationale for lifestyle risk factors considering physical activity and nutrition was based on guidelines [23, 24]. For assessing physical activity, participants were asked on how many days per week they had been breathless and sweated because of physical activity within the last three months. Participants, who were physically active for at least one day per week, were asked about the average duration of physical activity. The question could be answered on an ordinal scale (1 “Less than 10 minutes”, 2 “10 to less than 30 minutes”, 3 “30 to 60 minutes”, 4 “More than 60 minutes”).Based on the questions about frequency and duration of physical activity, a dichotomous variable was generated approximately fulfilling the recommendations of the American College of Sports Medicine and the American Heart Association [24]. Thus, physical activity for less than 30 min per day on five days per week was classified as lifestyle risk factor. Diet was assessed using a validated food frequency questionnaire (LML-6) of six items, asking how often somebody would eat low fat milk products, crudités, fresh salads, fresh herbs, fresh fruits and cereal products. The response categories ranged from 1 (rarely or never) to 5 (several times a day). A nutrition index was calculated [23] whereby a low index score (< 10) corresponded to an unhealthy diet indicating a lifestyle risk factor.

Selected variables for associations with extracted classes (predictors)

The following variables were selected to examine the association of the health lifestyle classes with external factors: sociodemographic factors, self-rated physical health (1 very good – 5 very bad), self-rated mental health (1 very good – 5 very bad), neurological diseases (no/yes), and a broad range of mental health problems within the last 12 months (i.e. depression).

To screen for mental health problems in the past 12 months, screening questions of the following sections of the Munich Composite Diagnostic International Interview (M-CIDI) [25] were used: panic attacks, general anxiety, social phobia, anxiety of public places, specific phobia, depression, mania and post-traumatic stress disorder (PTSD). Furthermore, the respondents were asked whether they

were in treatment for mental health problems or had been diagnosed with a mental disorder. All variables were dichotomized (no/yes).

Sociodemographic information was assessed by questions on gender (male, female), age (18 – 64 years), marital status (single, married, divorced, widowed) and education (low, average, high). Education was categorized into three groups according to the International Standard Classification of Education (ISCED) [26].

Data analysis

A latent class analysis (LCA) was performed on eight categorical lifestyle risk factors as described above. The LCA is a probabilistic model which identifies mutually exclusive classes (risk groups) of a non-directly measurable variable. The LCA calculates the probability that a particular person belongs to a certain (latent) class as well as the probability that an individual in a certain class will give a particular answer [27]. These probabilities are known as unconditional class membership probability and class-specific response probability. The exact number of classes of the latent variable is notspecified by the LCA. Goodness-of-fit measures (Bayesian Information Criterion (BIC), Entropy, Vuong-Lo-Mendell-Rubin adjusted Likelihood-Ratio-test (VLMR)) were used to select the best model. A low BIC, high Entropy and a significant VLMR indicate the best class-solution, but the final decision was also based on the researchers' assessment of the interpretability of the results [28]. We tested models with up to five classes. Since the sample of the ESA 2015 was drawn by a two-stage selection procedure, individuals were only selected at random within each sample point. The complex sampling of the ESA data required using a complex mixture term, since the results would be biased otherwise. Furthermore, all data was weighted in order to provide results which are representative for the general adult population in Germany. The LCA was performed in MPlus using maximum likelihood estimation with robust standard errors [29].

The conditional class membership probabilities were further used for a multinomial logistic regression [30] testing for associations of the classes with external factors (e.g. sociodemographic factors, mental health problems) as described above (listwise deletion of missing data). Classes were used as outcome variables and all predictors were included at once. Control variables were region, citizenship and mode of interview (paper-and-pencil, telephone, internet-based). The class with individuals showing mostly a healthy lifestyle class was used as reference category. Risk ratios as well as 95%-confidence intervals were calculated while using sampling weights. There was no sign of multicollinearity among the independent variables. The regression model was run in STATA 12.1 SE [31].

RESULTS

Respondent characteristics

. Table 1 presents raw and weighted prevalence rates for lifestyle risk factors. Low physical activity (82.6 %) and unhealthy diet (69.9 %) were the two most prevalent lifestyle risk factors . The lowest prevalence rates were reported for the use of illicit drugs (0.8 %) and the use of cannabis (3.1%). About one quarter of the respondents reported episodic heavy drinking and one fifth reported daily smoking.

Table 1

Raw and weighted prevalence rates for lifestyle risk factors (n = 9204)

Risk factors	Raw percentages		Weighted percentages	
	n	%	%	95%-CI
Daily Smoking	1322	14.5	18.5	[17.3,19.8]
At-risk drinking	1416	15.9	15.3	[14.4,16.3]
Episodic heavy drinking	2513	27.5	25.3	[24.0,26.7]
Cannabis use	386	4.2	3.1	[2.7,3.6]
Other illicit drugs use	75	0.8	0.8	[0.6,1.1]
Weekly pharmaceuticals use	733	8.0	8.2	[7.5,8.9]
Unhealthy diet	6185	67.4	69.9	[68.8,71.0]
Low physical activity	6423	84.1	82.6	[81.5,83.7]

Note. n = observed frequency of lifestyle risk factors, % = prevalence rates, 95%-CI = confidence intervals; weighted percentages: weighted for age, region, gender and education.

Latent class analysis and class profiles

Latent class models with one to five classes were estimated. Although the Entropy indicated a 3-class solution, the 4-class solution was selected as the final model due to better values of BIC, VLMR and the estimated class-specific response probabilities (> 0.8) (Table 2). Residual-based goodness-of-fit (standardized z-scores) showed only minor violations (> 1.96) of the assumption of local independence in all classes (data not shown) and therefore did not affect the selection of the final model.

Table 2

Goodness-of-fit measures and estimated class-specific response probabilities of the five investigated models for deciding the number of classes (n = 9204)

Number of classes	Goodness-of-fit measures			Estimated class-specific response probabilities				
	Entropy	BIC	VLMR	Class 1	Class 2	Class 3	Class 4	Class 5
1	-	53267	-	1.000				
2	0.634	51685	p < .001*	0.855	0.895			
3	0.737	51556	p = .018*	0.814	0.780	0.935		
4	**0.723**	**51513**	**p = .007***	**0.884**	**0.833**	**0.910**	**0.803**	
5	0.734	51535	p = .384	0.889	0.904	0.778	0.841	0.860

Note. BIC = Bayesian Information Criterion, VLMR = Vuong-Lo-Mendell-Rubin adjusted Likelihood-Ratio-Test, * p < .05.

Figure 1 presents the estimated class-specific response probabilities, which are showing the patterns of multiple lifestyle risk factors among the four classes.

Figure 1

Class 1 (58.5 %) was characterised by individuals with near-zero probabilities for most of the lifestyle risk factors, except low physical activity and unhealthy diet. In comparison to the other classes, class 1 can be characterised as the healthy lifestyle class.

Class 2 accounted for one fourth of the sample (24.4 %) and included individuals with high probabilities for risky alcohol consumption, episodic heavy drinking, low physical activity and unhealthy diet as well as moderate probabilities of daily smoking. Class 2 can be described as showing a risky drinking lifestyle. Compared with the healthy lifestyle class, individuals in class 2 were more likely to be younger, male and single as well as having an average education and a German citizenship (Table 3). Furthermore, individuals in the drinking lifestyle class were more likely to report symptoms of depression or PTSD (Table 4).

Class 3 (15.4 %) was characterised by individuals with high probabilities for daily smoking and for showing low physical activity and unhealthy diet. Class 3 was labeled as smoking lifestyle class. Compared with the healthy lifestyle class, individuals in class 3 were more likely to be single or divorced as well as having a lower education (Table 3). Moreover, the smoking lifestyle class included

more individuals who reported symptoms of specific phobia, depression or PTSD as well as bad physical health (Table 4).

The smallest class (1.7 %) showed high probabilities for the use of tobacco, alcohol, cannabis and other illicit drugs as well as for episodic heavy drinking, low physical activity and unhealthy diet. Class 4 can be described as showing a cumulate risk factors lifestyle. Compared with the healthy lifestyle class, individuals in class 4 were more likely to be younger, male,single or divorced (Table 3). Additionally, individuals in the cumulate risk factors lifestyle class were more likely to report symptoms of fear of public places (Table 4).

Table 3

Risk ratios (RR) and 95%-confidence intervals (CI) for sociodemographic factors associated with lifestyle risk factor classes

Variable		**Class 1** ***Healthy lifestyle*** *(Reference)*	**Class 2** ***Drinking lifestyle*** RR	95%-CI	**Class 3** ***Smoking lifestyle*** RR	95%-CI	**Class 4** ***Cumulate risk factors lifestyle*** RR	95%-CI
Gender	Male		1	1	1	1	1	1
	Female		0.30**	[0.26;0.34]	0.82	[0.67;1.00]	0.24**	[0.14;0.41]
Age	Age		0.98**	[0.97;0.98]	1.01	[1.00;1.01]	0.94**	[0.92;0.97]
Education	ISCED 1		1	1	1	1	1	1
	ISCED 2		1.39*	[1.10;1.75]	1.01	[0.71;1.42]	0.72	[0.37;1.38]
	ISCED 3		1.15	[0.89;1.49]	0.47**	[0.33;0.67]	0.54	[0.28;1.07]
Citizenship	German		1	1	1	1	1	1
	Other		0.72*	[0.54;0.95]	1.12	[0.75;1.66]	0.27	[0.06;1.28]
Region	West		1	1	1	1	1	1
	East		0.91	[0.76;1.09]	1.09	[0.87;1.35]	0.69	[0.37;1.28]
Marital status	Single		1	1	1	1	1	1
	Married		0.79*	[0.66;0.94]	0.79*	[0.62;0.99]	0.24*	[0.09;0.62]
	Widowed		0.23*	[0.10;0.55]	0.74	[0.37;1.48]	-	
	Divorced		1.03	[0.73;1.48]	1.51*	[1.04;2.21]	3.37*	[1.08;10.56]

Note. The healthy lifestyle class was used as reference category. The results from the regression model are presented in two tables (table 2 and table 3) for reasons of clarity and comprehensibility, but only one regression model was calculated. *p<0.05, **p<0.001, RR Risk Ratio, 95%-CI 95 % confidence interval. ISCED International Standard Classification of Education.

Table 4

Risk ratios (RR) and 95%-confidence intervals (CI) for self-rated physical health, neurological diseases, self-rated mental health and mental health problems associated with lifestyle risk factor classes.

Variable		**Class 1** ***Healthy lifestyle*** *(Reference)*	**Class 2** ***Drinking lifestyle*** RR	95%-CI	**Class 3** ***Smoking lifestyle*** RR	95%-CI	**Class 4** ***Cumulate risk factors lifestyle*** RR	95%-CI
Physical health			0.99	[0.89;1.09]	1.17*	[1.01;1.36]	1.26	[0.85;1.87]
Neurological disease			0.74	[0.50;1.09]	0.93	[0.61;1.41]	1.03	[0.38;2.80]
Mental health			0.99	[0.90;1.09]	1.01	[0.87;1.18]	1.28	[0.88;1.84]
Mental health problems	Psychosomatic complaints		0.91	[0.73;1.13]	0.97	[0.73;1.29]	0.94	[0.43;2.03]
	Panic attacks		0.91	[0.73;1.14]	0.84	[0.64;1.11]	0.92	[0.47;1.80]
	Generalized Anxiety Disorder		1.05	[0.88;1.25]	0.98	[0.79;1.23]	1.02	[0.56;1.88]
	Social Phobia		0.94	[0.72;1.23]	0.89	[0.63;1.26]	1.37	[0.71;2.62]
	Fear of public places		1.01	[0.62;1.63]	1.26	[0.74;2.14]	2.86*	[1.06;7.71]
	Specific Phobia		1.00	[0.77;1.31]	1.36*	[1.02;1.81]	1.33	[0.59;3.00]
	Depression		1.28*	[1.09;1.51]	1.56**	[1.25;1.94]	1.79	[0.96;3.31]
	Mania		1.12	[0.83;1.51]	1.24	[0.87;1.77]	1.93	[0.98;3.78]
	PTSD		1.17*	[1.01;1.35]	1.44*	[1.13;1.83]	1.23	[0.69;2.19]
In treatment/diagnosed mental disorder			0.81	[0.62;1.06]	1.15	[0.85;1.55]	0.42	[0.17;1.04]

Note. The healthy lifestyle class was used as reference category. The results from the regression model are presented in two tables (table2 and table 3) for reasons of clarity and comprehensibility, but only one regression model was calculated. *p<0.05, **p<0.001, RR Risk Ratio, 95% CI 95 % confidence interval.

DISCUSSION

Patterns of lifestyle risk factors

Our study identified four classes of lifestyle risk factors in the German population which can be best described as a healthy lifestyle (58.5 %), a drinking lifestyle (24.4 %), a smoking lifestyle (15.4 %) and a cumulate risk factors lifestyle (1.7 %).

In a systematic review of multiple lifestyle risk factors, Noble and colleagues [7] reported that the majority of the respondents (81 %) in the included studies belonged to a class, which did not show any lifestyle risk factors. Furthermore, 33 % of the studies reported a class showing a drinking lifestyle [7]. In contrast to these studies, we found patterns of lifestyle risk factors which were not reported in previous literature so far. The smallest class was characterised by high probabilities for using all included legal and illicit substances (cumulate risk factors lifestyle). To our knowledge, the consumption of illicit drugs has not been studied before in relation to a class analysis of multiple lifestyle risk factors in a nationally representative sample. Our results suggest including the consumption of illicit drugs in further analyses about multiple lifestyle risk factors in general adulthood and not constraining it to analyses in adolescence. Furthermore, two systematic reviews found a strong association between drinking and smoking [7, 32]. In the present study, individuals with a high probability for risky alcohol consumption and episodic heavy drinking also had a moderate probability for smoking on a daily basis (class 2). On the other side, individuals with a very high probability for smoking did not have a higher probability for showing risky alcohol consumption (class 3). For further class analyses of multiple lifestyle risk factors, it seems to be an asset to include episodic heavy drinking as well as risky alcohol consumption or alcohol misuse.

Although the results of the present study are consistent with two systematic reviews in some ways [7, 32] one should be careful by comparing the results. Previous studies classifying lifestyle risk factors used various definitions, measurements and cut off points for multiple health behaviour, different statistical methods and diverse samples [7, 32]. Identifications of classes of multiple lifestyle risk factors in a national population on the basis of latent class analysis as the present study has demonstrated have been limited in previous research.

Although the results indicated that more than half of the German population practiced a relatively healthy lifestyle regarding consumption of alcohol, tobacco or illicit drugs, even individuals in the healthy lifestyle class showed low physical activity and unhealthy diet. Nonetheless, compared to the other classes, the risk for unhealthy diet was less pronounced for individuals with a healthy lifestyle. Although physical activity and nutrition were not distinctive, the structure of the final class solution

preserved if the two variables were not included (sensitivity analyses not shown). In contrast, other German studies found class solutions with differences in regard to physical activity and nutrition [10, 11]. A possible explanation for this might be that these studies used different definitions of physical activity and nutrition and also used a lower threshold for high physical activity. Schneider and colleagues [11] for example defined physical activity as being active for one hour per week within the last year. In addition, the ESA 2015 was only able to assess moderate-intensive physical activity and not vigorous-intensive physical activity, which could have led to an underestimation of physical activity in the sample. As a consequence, the questions for assessing physical activity have been completely revised for future assessments in ESA. Furthermore, nutrition was assessed with a food frequency questionnaire (LML-6) consisting of six items due to limited space [23]. Even though the LML-6 was validated, a different questionnaire with more items could have assessed nutrition and unhealthy diet more precisely.

Factors associated with multiple lifestyle risk factors

Men were more likely to be in the drinking lifestyle (24.4 %) or cumulate risk factors lifestyle class (1.7 %) compared with women. This is coherent with literature, which reports that men have a higher risk of morbidity and mortality, because of their higher prevalence of lifestyle risk factors in general [33]. In the ESA study, men were also more likely to consume tobacco, alcohol and cannabis than women [16]. It is well known that men also have a higher risk of mortality and morbidity compared to women, but prevention and health promotion strategies are currently more often provided for both genders or especially for women [33]. In the future, prevention and health promotion strategies should focus especially on men.

Younger people were also more likely to be in the drinking lifestyle or cumulate risk factors lifestyle class. Previous research showed inconsistent associations between age and multiple lifestyle risk factors. Some studies found no clear associations, whereas others also reported that younger individuals were more likely to show multiple lifestyle risk factors [7, 34]. It seems possible that there might be underlying factors which could not be controlled for in this study, but could have mediated the association between age and lifestyle risk factors, for example personality traits, household income, peer groups and social networks [35]. Those underlying factors should be included as moderators or mediators in analyses between age and lifestyle risk factors in the future.

Individuals who were single had a higher risk to have a drinking lifestyle, a smoking lifestyle or cumulate risk factors lifestyle compared to married individuals. Social relationships can have an influence on health behaviour. Especially women tend to show a regulatory role in intimate

relationships and organize favorable lifestyle behaviours, for example the preparation of a balanced diet [36, 37]. It should be noted that the term “single” in the present study also includes individuals who have an intimate relationship but are not married. Nevertheless, it can be expected that the differences between married and single individuals in regard to the lifestyle risk class can be attributed to individuals who are not in an intimate relationship. Drefahl and colleagues [38] argued that the socioeconomic status plays an important role in regard to health behaviour and marital status. In his study cohabiters who were not married and possessed a high socioeconomic status had a lower risk for mortality than married couples [38]. Further research should investigate how intimate relationships in particular have an influence on lifestyle risk factors and if there might be more underlying factors explaining this association.

Additionally, in the present study people with a German citizenship were more likely to be in the drinking lifestyle class. A study by Strupf and colleagues [39] also reported differences among people with and without migration background considering alcohol consumption, but further research is needed to assess motives for episodic heavy drinking among various cultural groups.

Furthermore, education was also associated with lifestyle risk groups. Individuals with a lower education were more likely to have a smoking lifestyle, whereas individuals with a moderate education were more likely to have a drinking lifestyle. It is consistent to literature that smoking is associated with lower education [40, 41] and lifestyle risk groups which are including alcohol intake, are associated with higher education [7, 42]. Future research should address the question, if the educational level has an effect on the awareness of health-compromising effects regarding at risk alcohol consumption and smoking.

Associations between lifestyle risk groups and mental health

The present study also looked at associations between lifestyle risk classes and mental health problems, which has not been done before with a nationally representative sample in Germany. Compared with the healthy lifestyle class, individuals in the cumulate risk factors lifestyle class were more likely to report symptoms of fear of public places. The National Academy of Science recently reported that there is a moderate statistical association between regular cannabis use and increased symptoms of social anxiety [43]. Also consistent with the scientific literature were the findings that individuals with a drinking lifestyle were likely to report symptoms of depression [18] and that individuals with a smoking lifestyle were more likely to report symptoms of depression, PTSD or specific phobia [17]. On the other side it is also possible that people with mental health problems are

more likely to use legal or illicit substances for self-medication [44]. Since we investigated correlations and not causality, these results should be interpreted with caution.

Limitations

One shortcoming of this study is that the ESA study design does not reach certain subgroups with increased rates of substance consumption, i.e. homeless people or inmates [45]. A further risk of bias results from the data collection in the form of self-reports which are prone to social desirability bias [21]. Unfortunately, the ESA 2015 *data collection did not* distinguish between the usage of non-prescribed opioid and non-opioid pharmaceuticals within the last 30 days. Furthermore, it was not assessed if participants had misused prescribed pharmaceuticals. Since the present study was a cross-sectional analysis, one cannot tell if individuals change between lifestyle risk groups over lifetime. In the future, research with longitudinal studies in regard to this topic is necessary as well as the investigation which factors could lead to a change of health behaviour.

Despite these limitations, the ESA provides a large sample and a good response rate [21]. Furthermore, based on the use of different modes of administration and weighting procedures, the ESA provides representative estimates for lifestyle risk factors in the general adult population in Germany.

Conclusions

The study showed patterns of lifestyle risk factors regarding the use of alcohol, episodic heavy drinking, tobacco, cannabis, other illicit drugs, pharmaceuticals as well as nutrition and physical activity. Some of the associations between lifestyle risk factors are already well documented in the literature, which emphasizes the plausibility of the results that were found. However, the study also adds new contributions to the scientific community. Based on the outcomes, we recommend three practical implications for the German population:

1) Young and single men were more likely to have an alcohol or cumulate risk factors lifestyle. In the future, prevention and health promotion strategies should focus especially on men, since they also have a higher risk for morbidity and mortality in general [33].

2) Individuals with various mental health problems were more likely to show multiple lifestyle risk factors. Prevention and health promotion strategies should address the associations between multiple lifestyle risk factors and mental health problems. Additionally, professionals at the health-care sector should also look at multiple lifestyle risk factors in patients with probable mental health disorders.

3) The high probabilities for unhealthy diet and low physical activity emphasize the importance of the promotion of regular physical activity and healthy nutrition in wide sections of the German population through intervention and prevention measures.

Contributors

DP, LK and EG designed the study and supervised the process of data collection. JA, EG and DP were responsible for data cleaning and creating the final dataset. JA conducted the statistical analysis and wrote the manuscript. DP and CA played a major role for developing the final outline for analyzing the data. All authors contributed to and have approved the final manuscript.

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Competing Interests:

LK and DP declare having received a grant from Lundbeck GmbH for a research project on alcohol epidemiology not related to this study. JA, CA and EG declare having no conflict of interest.

Data sharing statement

For scientific purposes it is possible to use the raw data of the Epidemiological Survey of Substance Abuse. All datasets (since 1980) are archived at GESIS Leibniz Institute for Social Research and can be requested there.

What is already known to this subject?

- Multiple lifestyle risk factors are more detrimental to health compared with single lifestyle risk factors
- German studies have solely examined patterns of multiple risk factors for subsamples (i.e. job-seekers, elders), which are not representative for the general population
- The identification of classes based on lifestyle risk factors might facilitate the development of specific health promotion strategies for different vulnerable population groups

What this study adds?

- The present study is the first of its kind in this research area which also included the consumption of pharmaceuticals and illicit drugs into the latent class analysis.
- The results of the latent class analysis included a cumulate risk factors lifestyle class with high probabilities for consuming tobacco and illicit drugs, showing risky alcohol consumption and episodic heavy drinking, which speaks for including the consumption of illicit drugs in future analyses about multiple lifestyle risk factors.
- Compared to a healthy lifestyle, younger and single men were more likely to have an alcohol or cumulate risk factors lifestyle
- Individuals with various mental health problems were more likely to show multiple lifestyle risk factors

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LEGEND

Figure 1. Estimated class-specific response probabilities for eight lifestyle risk factors.

Note. A high score indicates a high probability of showing a lifestyle risk factor

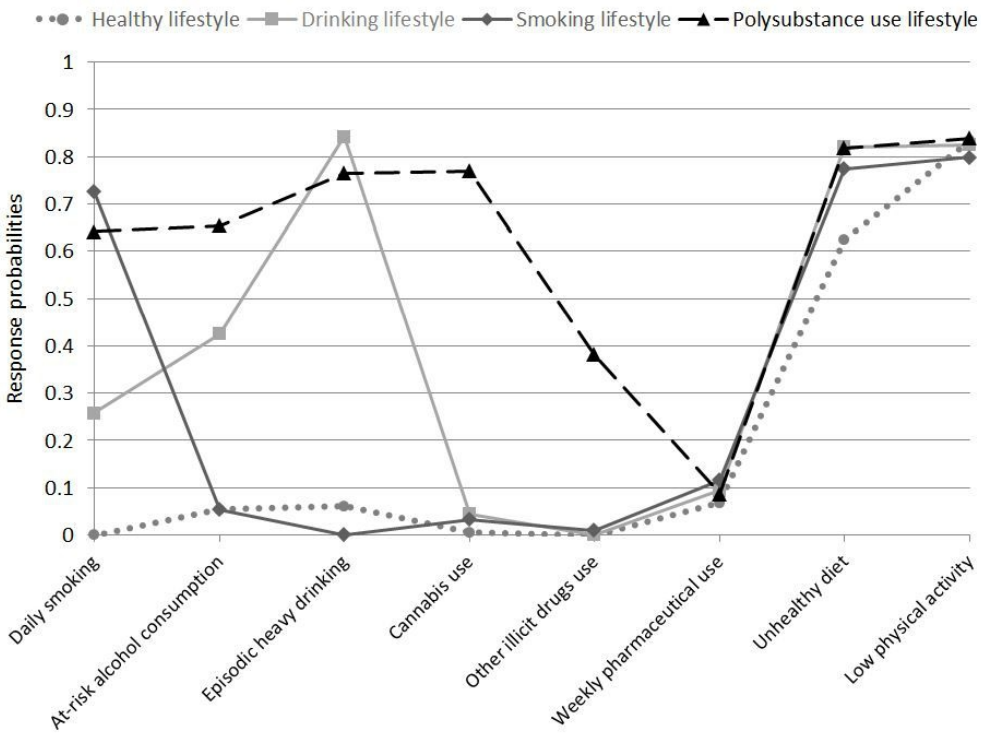

Figure 1. Estimated class-specific response probabilities for eight lifestyle risk factors. Note. A high score indicates a high probability of showing a lifestyle risk factor

77x57mm (300 x 300 DPI)

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Comments
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2	
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2	
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4	
Objectives	3	State specific objectives, including any prespecified hypotheses	4-5	
Methods				
Study design	4	Present key elements of study design early in the paper	5	
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5	A reference is cited with more detailed information of of methodology and design of the ESA 2015: Piontek D, Kraus L, Gomes De Matos E, Atzendorf J (2016) The 2015 Epidemiological Survey of Substance Abuse: Study Design and Methodology. Sucht 62:259-269.
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	/	A reference is cited with more detailed information of of methodology and design of the ESA 2015 Piontek D, Kraus L, Gomes De Matos E, Atzendorf J (2016) The 2015 Epidemiological

				Survey of Substance Abuse: Study Design and Methodology. Sucht 62:259-269.
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	/	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-7	
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	5-7	
Bias	9	Describe any efforts to address potential sources of bias	16	Methodological limitations are mentioned in the discussion section.
Study size	10	Explain how the study size was arrived at	5	A reference is cited with more detailed information of of methodology and design of the ESA 2015: Piontek D, Kraus L, Gomes De Matos E, Atzendorf J (2016) The 2015 Epidemiological Survey of Substance Abuse: Study Design and Methodology. Sucht 62:259-269.
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5-7	
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7	
		(*b*) Describe any methods used to examine subgroups and interactions	7	
		(*c*) Explain how missing data were addressed	7	
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed	/	A reference is cited with more

		Case-control study—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy		detailed information of of methodology and design of the ESA 2015: Piontek D, Kraus L, Gomes De Matos E, Atzendorf J (2016) The 2015 Epidemiological Survey of Substance Abuse: Study Design and Methodology. Sucht 62:259-269.
		(*e*) Describe any sensitivity analyses	14	The sensitivity analysis is not shown in the method section, because it is more relevant for the discussion.
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	/	A reference is cited with more detailed information of of methodology and design of the ESA 2015: Piontek D, Kraus L, Gomes De Matos E, Atzendorf J (2016) The 2015 Epidemiological Survey of Substance Abuse: Study Design and Methodology. Sucht 62:259-269.
		(b) Give reasons for non-participation at each stage		
		(c) Consider use of a flow diagram		
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	5, 8	
		(b) Indicate number of participants with missing data for each variable of interest		
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)		
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time		
		Case-control study—Report numbers in each exposure category, or summary measures of exposure		
		Cross-sectional study—Report numbers of outcome events or summary measures	8-12	

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	8, 11-12	The authors chose not to show unweighted percentages, since only the weighted percentages are representative for the general adult population in Germany.
		(*b*) Report category boundaries when continuous variables were categorized	/	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	/	

Continued on next page

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	18	Summarise key results with reference to study objectives
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
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21	Discuss the generalisability (external validity) of the study results
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

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

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.