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Health related behaviour patterns in Denmark during the first COVID 19 wave

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Abstract

Objective The COVID-19 pandemic raised concerns about how lockdowns affected health-related behaviours. This study aimed to identify patterns of health-related risk behaviours in Danish adults during the first pandemic wave.

Methods We used data from the Danish part of the Collaborative Outcomes study on Health and Functioning during Infection Times (COH-FIT), collected in May 2020 with recruitment through social media and newsletters. Responses were weighed against a Danish representative 2021 sample. Self-reported health-related behaviours were dichotomised into high-risk or not, and Latent Class Analysis was used to identify behavioural subgroups based on sedentary behaviour, media use, substance use, and harmful behaviours. We also examined pre- to during-pandemic changes in behaviour and subgroup demographics.

Results Five behavioural subgroups were identified. The largest group (53%) reported low to modest levels of high-risk behaviours. Two medium-sized groups included one (23%) with high media use, tobacco use, and aggression/self-harm, and another (18%) with low levels of most high-risk behaviours but moderate cannabis use and relatively high aggression. Two smaller high-risk groups included one (3%) with aggression, alcohol use, and physical inactivity, and another (2%) with smoking, cannabis, and gaming. Increases from pre-pandemic levels were most common in social media use (47%), TV viewing (46%), and internet use (41%).

Conclusions These findings suggest the pandemic intensified pre-existing risk behaviours rather than introducing new ones. Public health strategies should consider behaviour clustering to better support vulnerable subgroups. While limited by a cross-sectional, retrospective design, the study contributes valuable insight into behaviour patterns during societal disruptions.

1 Introduction

After the World Health Organization declared a global pandemic on March 11, 2020, the Danish government implemented a nationwide lockdown to curb the spread of the virus. The lockdown affected all aspects of everyday life and involved several physical-distancing measures, causing widespread societal disruptions and substantial changes in work,

educational and leisure environments. Remote work and online teaching were widely implemented, and screen use from video and online games, television, and internet use increased [1]. Following the initiation of the lockdown, there was concern that the lockdown measures and the associated difficulties in adjusting could negatively impact behavioural health determinants such as physical activity levels and sedentary behaviour [2], aggression [3], self-harm [4], and use of substances [5]. On the other hand, the COVID-19 pandemic might have motivated people to make healthier choices and adopt a healthier lifestyle. Another concern was the impact on mental health and the potential worsening of symptoms among people with existing mental illnesses [6]. This group may have been particularly vulnerable, as mental illness is associated with sedentary behaviour, alcohol consumption, and cannabis and tobacco use, among other behavioural health determinants [7]. Thus, the behavioural impact of the pandemic likely differed across population groups.

Recently, research on health-related behaviours has shifted from single-factor analyses to approaches that account for multiple interconnected factors. Latent Class Analysis (LCA) has been utilised to identify clusters and types of behaviour based on individuals' response patterns, providing deeper insights into subgroup differences. While several studies have applied LCA to examine behaviours during the pandemic [8–11], to our knowledge, no such studies have yet been conducted in a Scandinavian setting, where societal structure and public health responses differ from other regions.

In this study, we aimed to describe the distribution of health-related risk behaviours in the first wave of the COVID-19 pandemic in an adult Danish population with high proportion of individuals with mental health issues during the first wave of the COVID-19 pandemic. Furthermore, we aimed to examine clusters of these health-related risk behaviours and assess whether these health-related risk behaviours differed from reported levels before COVID-19 as a proxy for change in health-related behaviours during the initial months of the pandemic. Understanding health-related risk behaviours and potential changes during lockdown is important not only for their impact on health outcomes but also for informing disaster preparedness and guiding targeted public health interventions during future crises.

2 Methods

2.1 Setting

On February 26, 2020, Denmark confirmed its first case of COVID-19. Following the WHO's declaration of a global pandemic on March 11, 2020, the Danish government implemented a national lockdown, which included several restrictions, including assembly bans, guidelines on social distancing, the closure of educational institutions, daycare facilities, restaurants, fitness centers, sports activities, and cultural venues. Public sector employees were required to work from home, with similar recommendations for private companies, and legal sanctions were introduced for public gatherings exceeding 100 people. By May 2020, some restrictions were eased, allowing the reopening of outdoor sports facilities, museums, libraries, theatres, malls, and zoos, but the remaining restrictions were still in place and people were encouraged to continue social distancing. However, during the winter of 2020/2021, a second wave emerged, causing the reintroduction of most restrictions along with new measures, such as widespread mask use in indoor public spaces and on public transportation. A national vaccination program was

launched in early 2021, and by the time the highly contagious Omicron variant triggered a third and final wave in the fall of 2021, resulting in a sharp rise in cases and hospitalizations, only a few restrictions remained in effect.

2.2 Data

The study is based on data from the Danish part of The Collaborative Outcomes study on Health and Functioning during Infection Times (COH-FIT), which is a large-scale survey, including more than 150 territories/countries from all six inhabited continents. COH-FIT aims to identify risk factors affecting the general population and vulnerable subgroups during the COVID-19 pandemic. Additional information about this global study is available elsewhere [12–15]. Data was collected through online questionnaires at three timepoints: in May 2020, in January 2021, and in January 2022. This study is solely based on the data collection during the first wave in May 2020. The questionnaire from 2020 was promoted by The Danish Mental Health Fund and the National Institute of Public Health, University of Southern Denmark, through newsletters sent to members and in news media as well as social media and was thus a convenience sample. Informed consent was obtained electronically from all participants at survey entry. To retrieve a representative sample of Danish adults (18 + years) according to sex, age, geographic position, educational attainment, and occupation the two subsequent data collections in 2021 and 2022 were performed by a survey agency. Data from 2021 were used to construct post-stratification weights applied to the 2020 data to improve representativeness. Technically, respondents from groups that were overrepresented (e.g. females with higher educational attainment) in the convenience sample had a lower weight, while respondents that were underrepresented had a higher weight to compensate the uneven and non-representative distribution.

2.3 Health-related behaviours

All information on health-related behaviours were self-reported through the questionnaire and subsequently dichotomised into categories indicating high-risk behaviour or not, respectively (Supplementary Table 1). The respondents were asked about 12 health-related factors, related to physical inactivity, media use, substances, self-harm, and aggression. For physical inactivity and alcohol consumption, we based the dichotomization on guidelines from the Danish Health Authority. For physical activity the guidelines were at least 30 minutes a day. Respondents reporting less than 30 minutes of physical activity on average were categorised as high-risk. In 2020, women were advised not to exceed 14 units of alcohol per week, and men were advised not to exceed 21 units per week. Responses reporting higher alcohol consumption than the guidelines were classified as high-risk behaviour. No national guidelines were available for tobacco use or media use during the study period. Unlike alcohol consumption, tobacco use is generally advised against without a defined safe threshold, and no evidence-based national recommendations exist for time spent on media for adults. Consequently, these behaviours were categorised based on a zero-tolerance principle for substance use and a relatively high level of media use. For tobacco respondents reporting at least one daily cigarette were categorised as high-risk behaviour. Respondents reporting having smoked at least 0.5 grams of cannabis equivalent to one joint within the past two weeks were considered high-risk, and respondents reporting having used other substances at least once within

the past two weeks were categorised as high-risk behaviour. For self-harm and aggressive behaviour, respondents reporting having self-harmed or having been physically aggressive to others at least once within the past two weeks were considered high-risk behaviour. For use of social media, internet, gaming, and TV, respondents were asked about their daily average (in hours) within the past two weeks. Respondents in the upper quartile were categorised as having a high-risk use. For reading, respondents in the lower quartile were categorised as high-risk behaviour.

2.4 Changes in health-related behaviour

Each question on the 12 health-related factors were followed by a subsequent question asking; *"And what about in the last two weeks of your "regular" life BEFORE the COVID-19 outbreak?"*. To evaluate changes in behaviour, we compared responses to these questions, calculating the difference between pre-pandemic and May 2020 levels. Respondents whose behaviour shifted toward higher-risk patterns (e.g., reduced physical activity) were classified as having changed to an unhealthier behaviour regardless of the extent of the change.

3 Background characteristics

Information on background characteristics were self-reported and included sex, age, educational attainment, job status, and history of mental illness. Educational attainment was categorised according to the highest level achieved: none or primary education (short), high school or vocational education (medium), and college, university, or PhD degree (long). categorised. To obtain information about mental illness, respondents were asked whether they had ever been diagnosed with mental health conditions by a doctor or psychologist. Information on job status was gathered through two questions: one inquiring whether the respondent had a job and a follow-up question for those who answered 'yes,' asking if the job was within the health care sector.

3.1 Statistical analysis

We first assessed the proportion of respondents reporting high-risk health-related behaviours in the total study population in May 2020 and pre-pandemic as well as the proportion of respondents changing towards more high-risk behaviour when comparing the two (Table 1). We then used LCA to identify distinct subgroups of respondents based on their patterns of health-related behaviour operationalised by the variables listed in Table 1. LCA is a statistical model that identifies unobserved (latent) subgroups within a population by examining response patterns across observed categorical variables. Model fit statistics and interpretability of latent classes were considered in selecting the optimal number of classes. Each respondent was assigned to a class based on their highest posterior probability. We then labeled the resulting groups based on their distinguishing characteristics relative to the overall sample and other groups and visualised the prevalence of risk behaviours within each group (Fig. 1). Next, we assessed behavioural changes by calculating the difference between pre-pandemic and during-pandemic (May 2020) levels for each respondent. A decrease in reported time spent on physical activity and reading/studying was categorised as a change toward more high-risk behaviours. In contrast, an increase in behaviour within the remaining domains was considered a change toward more risk behaviours. We then reported the proportion of respondents in each group

Table 1 Distribution of risk behaviours in the total study population for May 2020 ($n = 2043$) and pre-pandemic and changes towards more risk-behaviour when comparing the two

	May 2020 ***n*** **(%)**	**Pre-pandemic** ***n*** **(%)**	**Change towards more risk behaviour[a]** ***n*** **(%)**
Physical inactivity	1190 (58)	1008 (49)	701 (34)
Social media	798 (39)	533 (26)	958 (47)
Internet	598 (29)	733 (36)	841 (41)
Gaming	627 (31)	788 (39)	677 (33)
TV	625 (31)	591 (29)	946 (46)
Low level of reading/studying	597 (29)	660 (32)	316 (15)
High alcohol intake	137 (7)	100 (5)	660 (32)
Tobacco	336 (16)	327 (16)	196 (10)
Cannabis	111 (5)	113 (6)	56 (3)
Other substances	37 (2)	53 (3)	15 (1)
Self-harm	128 (6)	101 (5)	90 (4)
Aggressive act	170 (8)	84 (4)	142 (7)

[a]Proportion reporting change towards more risk behavior when comparing reported pre-pandemic levels and reported May 2020 levels

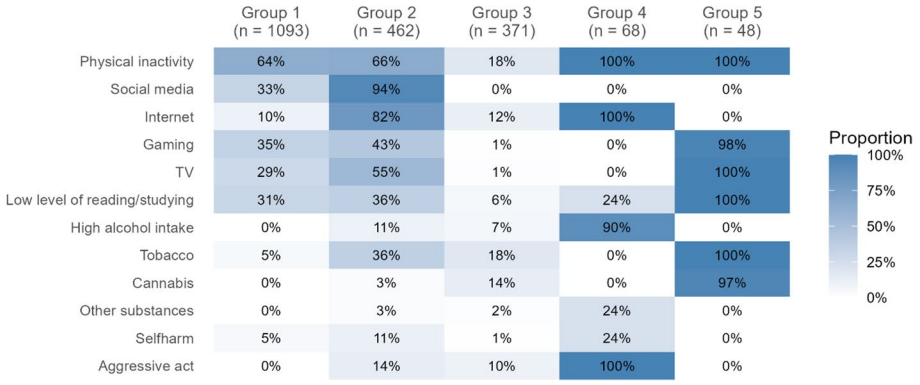

Fig. 1 Distribution of high-risk behaviours across five latent class analysis-identified groups in the study population. Percentages represent the proportion of individuals within each group exhibiting the specified high-risk behaviours. Group 1: Moderate use of media, and low substances. Group 2: High use of media and tobacco. Group 3: Low-risk, low inactivity, and moderate cannabis. Group 4: High aggression, alcohol, and inactivity. Group 5: High tobacco, cannabis, and gaming

who exhibited such changes (Fig. 2). Finally, we described the background characteristics of each group to provide a profile of their composition (Table 1).

4 Results

4.1 Health-related behaviour during the early pandemic

Table1 presents the distribution of high-risk behaviours in the total study population ($n = 2043$) in May 2020, pre-pandemic (last two weeks before the first lock-down), and changes towards more risk-behaviour. In May 2020, the most prevalent high-risk behaviour was physical inactivity with 58% of respondents not meeting the national guideline of 30 minutes of daily activity, which is higher than the pre-pandemic level of 49%. Regarding substances, 7% exceeded national alcohol intake guidelines in May 2020, 16% smoked daily, 5% used cannabis, and 2% had used other substances in the past two weeks. The prevalence during the first COVID-19 wave was slightly higher for alcohol use (May 2020: 7% vs. pre-pandemic: 5%) compared to the pre-pandemic period,

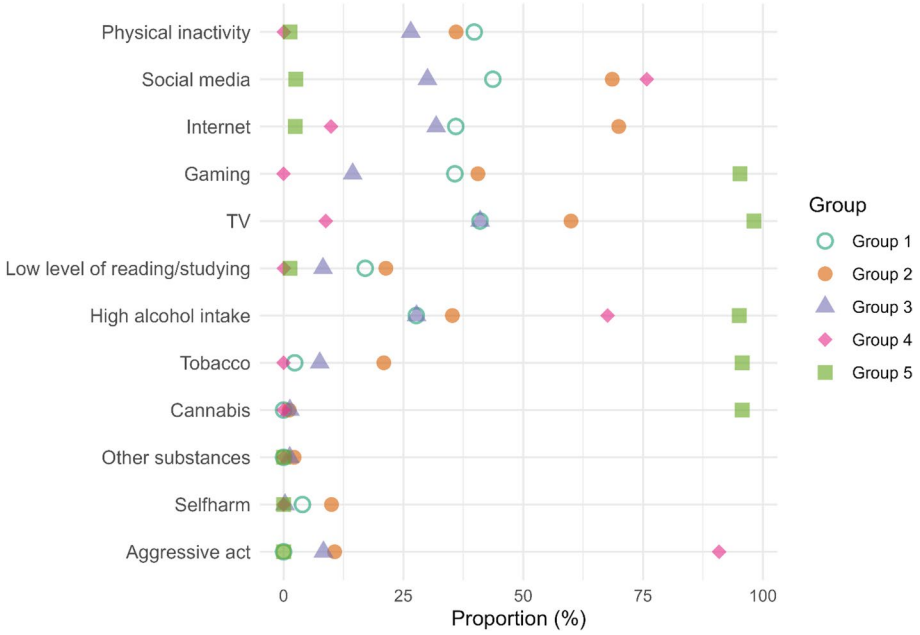

Fig. 2 Distribution of increased high-risk behaviours from pre-pandemic levels to May 2020 across five Latent Class Analysis-identified groups in the study population. Percentages represent the proportion of individuals within each group reporting change towards more risk-behaviour when comparing May 2020 to reported pre-pandemic levels. Group 1: Moderate use of media, and low substances. Group 2: High use of media and tobacco. Group 3: Low-risk, low inactivity, and moderate cannabis. Group 4: High aggression, alcohol, and inactivity. Group 5: High tobacco, cannabis, and gaming

but stable for tobacco, cannabis, and other substance use. Additionally, the proportion reporting self-harm was relatively stable, whereas the proportion reporting being physically aggressive towards others doubled (8% vs. 4%). Social media, internet use, gaming, TV watching, and reading ranged from 29% to 39% in May 2020. Compared to pre-pandemic levels, the prevalence was higher for social media (39 vs. 26%), slightly higher for TV use (31% vs. 29%), and lower for reading (29% vs. 32%), internet use (29% vs. 36%), and gaming (31% vs. 39%).

Based on model fit indices and interpretability, the five-class solution was selected as the best representation of the data, offering a better balance than models with four or six classes. Figure 1 illustrates the distribution of 12 high-risk behaviours across the five groups identified in the LCA. The largest group, 'moderate use of media, and low substances' (group 1, 53%), exhibited risk levels similar to the total study population but with low internet use and no excessive alcohol or substance use. The 'high use of media and tobacco' group (group 2, 23%), was characterised by elevated social media, internet, TV, gaming, and tobacco use compared to the other groups. In addition, this group was characterised by 11% engaging in self-harm and 14% displaying aggression. The 'low-risk, low inactivity, and moderate cannabis' group (group 3, 18%), had generally low levels of high-risk behaviours but included 14% cannabis smokers and 10% with aggressive behaviour. Two smaller groups were identified: A 'high aggression, alcohol, and inactivity' group (group 4, 3%), where all members reported aggression, physical inactivity, and high internet use, and with 90% exceeding national alcohol guidelines; and a 'high tobacco, cannabis, and gaming' group (group 5, 2%), characterised by physical inactivity, high gaming and TV use, all smoking tobacco, and 97% reporting cannabis consumption.

4.2 Comparison with pre-pandemic levels

In the total study population, the largest increases towards more risk behaviour when comparing pre-pandemic levels to May 2020 were observed in social media use (47%), TV viewing (46%), internet use (41%), physical inactivity (34%), and gaming (33%) (Table 1). Additionally, alcohol intake increased for 32%, tobacco use for 10%, cannabis use for 3%, and other substance use for 1% of the study participants. Reading/studying time declined for 15%, while self-harm and aggression increased for 4% and 7%, respectively (Table 1).

Figure 2 illustrates the distribution of proportions shifting towards more risk behaviours when comparing May 2020 to pre-pandemic levels across the five groups. In the 'moderate use of media, and low substances' group, 44% reported an increase in social media use, 41% an increase in TV use, and 28% an increase in alcohol intake. In the 'high use of media and tobacco' group, 69% reported higher social media use, 70% more internet use, and around 10% reported increases in aggression and self-harm. In the 'low-risk, low inactivity, and moderate cannabis' group, 41% reported higher TV use, 32% higher internet use, 30% more social media use, and 8% increased aggression. The 'high aggression, alcohol, and inactivity' group was characterised by no increase in physical inactivity, but 10% reported increased internet use and 91% reported heightened aggression compared to pre-pandemic levels. In the 'high tobacco, cannabis, and gaming' group, 95–98% reported increases in gaming, TV use, alcohol, tobacco, and cannabis use, with only 1% reporting more physical inactivity.

4.3 Sociodemographic characteristics of the five groups

In the overall population, 53% were women and 47% men, with most respondents aged 18–30 years (29%) and 60+ (23%) (Table 2). Educational attainment were distributed as follows: 37% high, 33% medium, and 29% low. Most participants (78%) were employed, and 52% reported having a history of mental illness.

The moderate use of media and low substance use group closely resembled the total study population, with a slightly higher proportion of women (56%) and 37% having a high or medium education (Table 2). The high media use and tobacco group was also similar to the total population in most areas, but it had a larger proportion in the youngest age group (42%) and a slightly lower proportion with a high education level (32%). The low-risk, low inactivity, and moderate cannabis use group had a gender distribution similar to the overall population, with 56% having a high educational attainment. This group had a relatively low proportion of people with a history of mental illness (31%). The high aggression, alcohol use, and inactivity group consisted entirely of men (100%), with 75% having a low education level and no respondents in the youngest age group. 90% were employed and 67% reported having a history of mental illnesses. Finally, the high tobacco, cannabis, and gaming group was predominantly male (98%), with 95% aged 40–49 years, 94% having a low educational attainment. Most were employed (97%) and reported having a history of mental illness (96%).

5 Discussion

5.1 Summary of findings

Our findings highlight notable shifts in health-related behaviours during the early phase of the COVID-19 pandemic compared to pre-pandemic levels. Physical inactivity was

Table 2 Background characteristics of the five latent class analysis-identified groups, May 2020

	Group 1	Group 2	Group 3	Group 4	Group 5	Total
	Moderate use of media, and low substances	High use of media and tobacco	Low-risk, low inactivity, and moderate cannabis	High aggression, alcohol, and inactivity	High tobacco, cannabis, and gaming	
Sex						
Women	56%	57%	54%	0%	2%	53%
Men	44%	43%	46%	100%	98%	47%
Age group						
18–30 years	31%	42%	17%	0%	0%	29%
30–39 years	13%	8%	16%	24%	0%	13%
40–49 years	16%	15%	20%	67%	95%	20%
50–59 years	14%	24%	18%	0%	4%	16%
60 + years	27%	11%	29%	10%	1%	23%
Mean age (SD)	44 (17)	40 (16)	48 (16)	46 (10)	47 (3)	44 (16)
Educational attainment						
High	37%	32%	56%	1%	4%	37%
Medium	37%	34%	28%	24%	1%	33%
Low	26%	34%	16%	75%	94%	29%
Missing	0%	0%	0%	0%	0%	0%
Job status						
Employed	77%	76%	78%	90%	97%	78%
Unemployed	23%	24%	20%	10%	3%	22%
Missing	0%	1%	2%	0%	0%	1%
Mental illness						
Yes	56%	52%	31%	67%	96%	52%
No	44%	48%	66%	33%	4%	47%
Missing	0%	0%	3%	0%	0%	1%
Total (N)	1093	462	371	68	48	2043

Percentages are rounded and may not sum precisely to 100%

the most prevalent risk behaviour, affecting 58% of participants – an increase from 49% prior to the pandemic. Comparatively, social media use increased (May 2020: 39% vs. pre-pandemic: 26%), while internet use (29% vs. 36%) and gaming (31% vs. 39%) decreased, and TV and reading only slightly decreased. This pattern suggests that some of the increase in media use may have partially compensated for the 34% decrease in physical activity, potentially reflecting behavioural adaptations to environmental constraints such as gym closures during the lockdown. Substance use remained relatively stable, although a modest increase in alcohol use was observed (7% vs. 5%), alongside a notable rise in physical aggression (8% vs. 4%). The LCA revealed five distinct behavioural profiles. The sample included one large group (53%) named 'moderate media use and low substance use' (group 1), characterised by low to modest risk levels of high-risk behaviour. In addition, there were two medium-sized groups: one marked by high media and tobacco use along with elevated self-harm and aggression ('high media use and tobacco', group 2, 23%), and another showing generally low levels of high-risk behaviours but with moderate cannabis use and some aggression ('low-risk, low inactivity, and moderate cannabis use', group 3, 18%). Two smaller high-risk groups were identified: one characterised by aggression, alcohol use, and inactivity ('high aggression, alcohol use, and inactivity', group 4, 3%), and another defined by tobacco, cannabis, and gaming (high tobacco, cannabis, and gaming', group 5, 2%). Comparative analysis with pre-pandemic levels showed the largest increases in social media use (47%), TV viewing (46%), internet

use (41%), physical inactivity (34%), and gaming (33%). These increases were particularly pronounced within the two small high-risk groups. Sociodemographic characteristics varied across the five profiles, with the highest-risk groups predominantly comprising men, individuals with lower educational attainment, and middle-aged adults.

5.2 Comparison with previous studies

To the best of our knowledge, no previous studies have applied LCA to examine clusters of health-related behaviours during the COVID-19 pandemic within a Scandinavian context. Although studies from other countries have explored similar topics, the combinations of health-related behaviours assessed often differ from those in the present study, limiting direct comparability due to variations in behavioural scope, operational definitions, and study populations. For instance, a Canadian study by Tessier et al. used LCA to identify two lifestyle change pattern groups during the first year of the pandemic: a 'healthy' (60.5%) and a 'less healthy' (39.5%) group [16]. The study relied on self-reported data on weight, physical activity, eating habits, tobacco, alcohol use, and sleep quality reported in 2020 and for pre-pandemic levels. In line with our results, most of the study population exhibited healthy behaviour. The less healthy group reported weight gain, poorer diet and sleep quality, unchanged or increased alcohol and tobacco use, and reduced physical activity. In contrast to our approach, their definition of behavioural change was based on shifts between predefined categories – such as transitioning from meeting to not meeting WHO physical activity guidelines – whereas we applied a more granular definition, classifying any shift toward higher-risk behaviour (e.g., a reduction in weekly activity from 20 to 15 min) as a negative change. Other studies have examined clusters of unhealthy behaviours in specific subpopulations, such as Chinese adolescents [10] and people recovering from COVID-19 in Vietnam [17]. In line with our findings, both studies found most of the study population were in the low-risk group and highlight that men were more likely to exhibit high alcohol use. However, these studies are less directly comparable due to substantial differences in COVID-19 transmission rates, public health restrictions, healthcare infrastructure, and cultural norms.

A notable finding of the present study is that the two high-risk groups consisted almost exclusively of men and were characterised by high alcohol intake, tobacco and cannabis use, use of other substances, and elevated levels of aggression. These findings are consistent with existing evidence on sex differences in substance use and aggression [18, 19]. However, aggression was limited to physical forms; given that women more often engage in verbal or relational aggression, sex differences may have been less pronounced had these forms been included [19].

5.3 Strengths and limitations

The COH-FIT Danish data have several strengths. The rapid dissemination of the online survey in May 2020 enabled the assessment of 12 health-related risk behaviours early in the pandemic, along with comparisons to pre-pandemic levels. An important strength is the comprehensiveness of the dataset, which allows for the clustering of a wide range of behaviours, including physical activity, media consumption, and substance use in a large sample. Moreover, COH-FIT is a large-scale international collaboration, enabling future cross-country comparisons to explore how behavioural changes during the pandemic varied across different national contexts.

The Danish sample was recruited through newsletters and social media and therefore does not constitute a nationally representative sample. Respondents may be subject to self-selection bias, whereby individuals who felt particularly affected by the COVID-19 pandemic may have been more likely to participate. To address this, weights based on sex, age, and educational attainment derived from a representative 2021 sample were applied to the 2020 data to enhance generalizability. However, even after weighting, the 2020 sample differed from the 2021 sample, notably with higher proportions of respondents reporting mental illness. As the COH-FIT study did not specifically target individuals with a history of mental illness, this overrepresentation is likely attributable to self-selection bias.

However, this group was of particular interest given the heightened concerns about mental health during the early stages of the pandemic. Consequently, while the overrepresentation of individuals with mental illness may limit the generalizability of the findings to the broader population, our study provides valuable insight into this vulnerable group.

All behavioural items were followed by a question assessing pre-pandemic levels, allowing for the examination of change. However, due to the cross-sectional design, these retrospective self-reports may be influenced by recall bias, as participants might overestimate their pre-pandemic healthiness or underestimate past media use due to the current lockdown context. As longitudinal data from before the pandemic were not available for this cohort, direct validation of these reports was not possible, and we therefore highlight recall bias as an important limitation. Nevertheless, although it is impossible to dismiss the possibility that recall bias may have affected the magnitude of pre-post changes, all surveys were administered within a narrow time window (May 2020), suggesting that any such bias would be likely to operate similarly across participants. The structure of the questions may also have encouraged respondents to focus on perceived change, rather than relying on exact memory, thereby still offering useful insights into shifts in health-related behaviour. Furthermore, behavioural change was operationalised as any shift toward a higher-risk pattern, and participants were classified as having adopted unhealthier behaviours regardless of the extent of change. As a result, the approach did not capture the nuances or severity of changes towards more high-risk behaviour but may have been less sensitive to recall bias than approaches relying on the magnitude of change. Despite these limitations, the study provides valuable insights into the early behavioural shifts during the pandemic and contributes to a broader understanding of how health-related behaviours adapted in response to such a global crisis.

6 Conclusion

Using LCA, this study identified five distinct clusters of health-related behaviours among Danish adults during the early stages of the COVID-19 pandemic. While most respondents exhibited relatively low levels of high-risk behaviours, smaller subgroups demonstrated high levels of such, particularly in relation to physical inactivity, substance use, and aggression. When examining shifts toward higher-risk behaviours across the total study population, the largest increases from pre-pandemic to May 2020 were seen in social media use and TV viewing. Across groups, the most pronounced increases were generally observed in high-risk behaviours that were already prevalent within the respective groups in May 2020. This suggests that the pandemic may have intensified

existing patterns of risk behaviour rather than leading to the development of entirely new risk behaviours. These findings highlight the heterogeneous impact of the pandemic on health behaviours and underscore the need for tailored public health strategies that consider the clustering of risk behaviours. In particular, the clustering of high-risk profiles among men, especially those with low educational attainment, suggests a need for targeted prevention focusing on substance use and aggression. However, as aggression was operationalised as physical aggression only, sex differences should be interpreted with caution, and future studies incorporating verbal and relational aggression may reveal a more nuanced pattern. Given the cross-sectional design and reliance on retrospective self-reports, future research should aim to replicate these findings longitudinally and explore their implications for health outcomes. Nonetheless, the results provide important insights for preventive efforts during periods of societal disruption, particularly in identifying vulnerable subgroups.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12982-026-01687-7.

Supplementary Material 1.

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Author contributions
For the overall COH-FIT project, MS and CUC wrote the study protocol. LCT was responsible for the data collections in Denmark. TTS, GTO, PV, and LCT developed the study design for this specific study. TTS was responsible for the data analysis and wrote the first draft. All authors read, contributed to and approved the final version of the manuscript.

Data availability
The datasets analysed during the current study are not publicly available due to data protection regulations and governance restrictions associated with the fully anonymized COH-FIT dataset. The data were accessed under agreements with the data custodians and relevant authorities and therefore cannot be shared publicly. Data may be available from the authors upon reasonable request and subject to approval from the relevant authorities. Queries regarding data access can be directed to Lau Caspar Thygesen (lct@sdu.dk).

Declarations

Ethics approval and consent to participate
The study was conducted in accordance with the Danish Code of Conduct for Research Integrity, approved by the Research Ethics Committee at the University of Southern Denmark (SDU), and complied with the Danish Data Protection Act and the General Data Protection Regulation (GDPR; EU 2016/679). As this study used fully anonymized survey data, no additional ethics approval was required. The study was conducted in accordance with the principles of the Declaration of Helsinki. Informed consent was obtained from all participants prior to their participation in the survey. Participation in the COH-FIT survey was voluntary, and all respondents participated anonymously. Because no identifiable information was collected, individual responses could not be traced back to participants after submission. Consequently, withdrawal of consent or removal of submitted data was not possible.

Consent for publication
Participants provided informed consent for publication of anonymised and aggregated data prior to participating in the survey.

Competing interests
MS received honoraria/has been a consultant for Angelini, AbbVie, Boehringer Ingelheim, Lundbeck, Otsuka. CUCI has been a consultant and/or advisor to or has received honoraria from: AbbVie, Alkermes, Allergan, Angelini, Aristo, Autobahn, Boehringer-Ingelheim, Bristol-Meyers Squibb, Cardio Diagnostics, Cerevel, CNX Therapeutics, Compass Pathways, Darnitsa, Delpor, Denovo, Draig, Eli Lilly, Eumentis Therapeutics, Gedeon Richter, GH, Hikma, Holmusk, IntraCellular Therapies, Jamjoom Pharma, Janssen/J&J, Karuna, LB Pharma, Lundbeck, MedInCell, MedLink, Merck, Mindpax, Mitsubishi Tanabe Pharma, Maplight, Mylan, Neumora Therapeutics, Neuraxpharm, Neurocrine, Neurelis, Newron, Noven, Novo Nordisk, Otsuka, PPD Biotech, Recordati, Relmada, Response Pharmaeutical, Reviva, Rovi, Saladax, Sanofi, Seqirus, Servier, Sumitomo Pharma America, Sunovion, Sun Pharma, Supernus, Tabuk, Takeda, Teva, Terran, Tolmar, Vertex, Viatris and Xenon Pharmaceuticals. He provided expert testimony for Janssen, Lundbeck and Otsuka. He served on a Data Safety Monitoring Board for Compass Pathways, IntraCellular Therapies, Relmada, Reviva, Rovi. He has received grant support from Boehringer-Ingelheim, Janssen and Takeda. He received royalties from UpToDate and is also a stock option holder of Cardio Diagnostics, Kuleon Biosciences, LB Pharma, MedLink Global, Mindpax, Quantic, Terran.

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