Check for updates

ORIGINAL ARTICLE

Mental health among centenarians living in Switzerland

Kim UITTENHOVE [1,2] Shauna L. ROHNER [3,4] Justine FALCIOLA,[5] Carla GOMES DA ROCHA,[6,7,8] Christina RÖCKE,[3,9,10] Stefano CAVALLI,[11] François HERRMANN,[5] Daniela S. JOPP[1,2] and Armin von GUNTEN[6]

[1]Institute of Psychology and [2]LIVES Centre for Competence, University of Lausanne and [6]Service of Old Age Psychiatry, Lausanne University Hospital and University of Lausanne, Lausanne, [3]University Research Priority Program 'Dynamics of Healthy Ageing', [9]Centre for Gerontology and [10]Healthy Longevity Centre, University of Zurich, Zürich, [4]Competence Centre for Mental Health, Department of Health, OST – University of Applied Sciences of Eastern Switzerland, St. Gallen, [5]Department of Rehabilitation and Geriatrics, Faculty of Medicine, Geneva University Hospitals and University of Geneva, Geneva, [8]School of Health Sciences, HES-SO Valais-Wallis, Sion and [11]Centre of Competence on Ageing, University of Applied Sciences and Arts of Southern Switzerland (SUPSI), Manno, Switzerland and [7]Institute of Biomedical Sciences Abel Salazar, University of Porto, Porto, Portugal

Correspondence: Dr. Kim Uittenhove, Institute of Psychology, University of Lausanne, Geopolis, CH-1015 Lausanne, Switzerland. Email: kim.uittenhove@unil.ch

Abstract

Background: Given the increasing number of people achieving exceptionally long lifespans, there is an urgent need for a better understanding of mental health in centenarians. This study aimed to understand the prevalence of mental health conditions—depressive symptoms, anxiety, sleep disturbances, disinhibition, and aberrant motor behaviour—among centenarians in Switzerland.

Methods: Data were collected from $N = 169$ participants via telephone interviews or paper questionnaires, either directly from centenarians or through proxy informants. Half the data were collected during a period when protective measures were imposed due to the COVID-19 pandemic, and half were collected after the measures were lifted.

Results: Mental health conditions were prevalent in our sample, particularly depressive symptoms (44.51%) and anxiety (42.17%). Significant positive associations were found between depressive symptoms and anxiety, and between disinhibition and aberrant motor behaviour. Furthermore, we identified statistical predictors for the occurrence of mental health conditions. Notably, institutionalised living increased the odds of depressive symptomatology, while those with higher education levels or an absence of cognitive impairment experienced more sleep disturbances. Finally, cognitive impairment was linked to increased disinhibition and aberrant motor behaviour.

Conclusions: The high prevalence of mental health conditions underscores the need for proactive mental health care strategies in advanced old age. Moreover, it is vital to consider the interconnected nature of mental health conditions and to prioritise vulnerable groups, such as centenarians in institutional settings.

INTRODUCTION

It is a worldwide trend that an increasing number of people are achieving exceptionally long lifespans due to lifestyle changes and advancements in medical care (e.g., Teixeira *et al.*[1]). In Switzerland, there were 1949 centenarians residing in the country at the end of 2022, an increase of 3.2% compared to the previous year.[2] These rising numbers emphasise the need for a better understanding of mental health in centenarians. Cheng *et al.*[3] in their systematic literature review on anxiety and depression in (near-)centenarians, highlighted that most centenarian research focuses on physical, cognitive, and social health. In contrast, the exploration of mental health and its limitations in this age segment has been under-represented. This is concerning given the profound effect of mental health conditions, such as depression and anxiety, on the quality of life of the affected individuals[4] and their caregivers.[5] At the same time, a nuanced understanding of mental health in the later stages of life can also challenge the common stereotype that advanced old age is synonymous with deterioration of physical and mental health.[6]

Among older adults aged 65 and above, mental health conditions appear widespread. For instance, research by Andreas *et al.*[7] surveyed 3142 randomly selected individuals between the ages of 65 to 84 across several European nations. During the study period, in the years between 2013 and 2017, one in four participants was dealing with an active mental health condition. Anxiety disorders emerged as the most common burden, affecting 11.4% of the sample, followed by affective disorders, such as major depressive episode at 8%. Among the included countries, participants from Switzerland had the highest prevalence of affective disorders (15.6%), whereas the prevalence of anxiety disorders (7.8%) was average.[7]

In centenarian studies, the prevalence of mental health problems varies significantly, as underscored in the systematic review by Cheng *et al.*[3] For example, in near-centenarians, anxiety disorder rates were 5.9% in Sweden,[8] compared to 45.5% in Portugal.[9] Similarly, depressive symptom rates were 12.8% in Italy,[10] compared to 35.2% in Portugal.[11] In research comparing the prevalence of mental health conditions between older adults and centenarians, some studies point to a higher prevalence in centenarians,[12] while others find no significant difference.[13,14]

In western Switzerland, Mall *et al.*[15] studied the prevalence of mental health conditions in a sample of 58 nonagenarians and centenarians (age range: 90–103 years) living in nursing homes. Using the Neuropsychiatric Inventory Questionnaire, depressive symptoms (occurring in around 65% based on the visualisation in their paper) and anxiety (52%) were the most prevalent among participants. Sleep disturbances (25%) and aberrant motor behaviour (18%) were also encountered relatively often, whereas disinhibition was reported in approximately 8%. Understanding the prevalence of sleep disturbances in centenarians is of great importance, particularly as the COVID-19 pandemic may have heightened these issues through increased stress and altered daily routines.[16] Furthermore, aberrant motor behaviour and disinhibition are underexplored symptoms, highlighting a critical research gap.[17,18] These symptoms strongly impact social interactions and care needs and may pose specific challenges following a pandemic period, necessitating protective measures that included social restriction and confinement to a limited space. It is important to note that the prevalence rate of mental health conditions in centenarians is associated with several factors, including sociodemographic factors, such as female sex, low education, and living in institutions, as well as health status and cognitive impairment.[9,10,13,19–25] Investigating these correlates is important for the early identification of centenarians who are potentially at risk for the development of mental health conditions.

Beyond examining the prevalence of mental health conditions in centenarians, understanding their interrelationships within this population is equally vital. In their review of anxiety assessment in older adults, Balsamo *et al.*[26] noted increasing comorbidity between anxiety and depression with advancing age, with nearly half of older adults (55–89 years) with depression also meeting the criteria for an anxiety disorder. Similarly, relationships between depressive and anxious symptoms and sleep disturbances among older adults have also been documented in the literature.[27,28] These interrelations are relevant because comorbid mental health problems can amplify daily life impairments and present additional treatment challenges.[29] These complications are particularly detrimental in the context of very old age. Given the increasing number of older adults reaching very old age, and the rising prevalence and comorbidity of mental health conditions in this age group, there is an urgent need for research on mental health in this population.

The current study

Building on the aforementioned research and aiming to address existing knowledge gaps, our study investigated mental health among centenarians in Switzerland. Our primary goal was to ascertain the prevalence and interrelation of mental health conditions – specifically depressive symptoms, anxiety, sleep disturbances, disinhibition, and aberrant motor behaviour. Our secondary objective was to identify statistical predictors of mental health conditions, as risk or protective factors, including sociodemographic variables (i.e., age, sex, education level, living situation) and cognitive status. We also considered contextual variables, including whether the information came from centenarian self-reports or proxy informants, and the timeline in relation to COVID-19 protective measures (i.e., travel restrictions, social distancing, lockdowns) which were lifted on 26 June 2021. By addressing these objectives,

our study aimed to provide a more complete understanding of mental health among Swiss centenarians, and to allow identification of centenarians who present risk or protective factors.

MATERIALS AND METHODS
Study design
This research is part of the first nationwide centenarian study in Switzerland (SWISS100[30]). The analyzed data consist of cross-sectional assessments conducted via telephone interviews and paper questionnaires with centenarians and/or proxy informants (i.e., a person close to the centenarian such as a family member). Half of the reports (50.60%) were collected between 15 December 2020 and 26 June 2021, when protective measures were imposed by Swiss authorities due to the COVID-19 pandemic, and the remaining half were collected between 27 June 2021 and 29 June 2022, after the protective measures were lifted. The study protocol was approved by the Swiss Ethics Committees on research involving humans (ID 2020-02063) and was conducted in accordance with the Declaration of Helsinki and with the principles and procedures for integrity in scientific research involving human beings.

Study participants
Eligible participants were adults living in Switzerland aged 100 years or older (i.e., centenarians), as well as their proxy informants. Centenarians were contacted according to a pre-established random order within each Swiss canton, based on a list that was updated and provided by the Federal Statistical Office (FSO) at 3-month intervals. There were no exclusion criteria. We designed our study with the goal of being as inclusive as possible, enabling centenarians of diverse abilities to participate. This included proxy participation and mailed questionnaires when telephone participation was not feasible. We attempted to contact 772 eligible centenarians: of these, we were able to confirm that 182 individuals were deceased; there were also 214 failed contact attempts, often due to invalid information. We succeeded in reaching 376 centenarians. In 169 cases (44.9%), this led to study participation. In many situations, participation difficulty due to cognitive, hearing, or health limitations was resolved by proxy replacement (73 cases, or 43.2% of our sample) or by sending a paper questionnaire

(41 centenarian respondents, or 42.7% of centenarian self-reports). Concerning the 207 individuals (55.1%) who did not participate, refusal reasons were collected for 112, whereas we have no explicit reason collected for 95 cases. Participation refusals were mainly due to cognitive, hearing and health limitations, cited in 51 cases (45.6%), or to unwillingness resulting from lack of interest, distrust, or perceived burden of participation, mentioned in 58 cases (51.8%). Among the limitation-related refusals, cognitive and hearing issues were each reported in 24 cases, with 16 citing other health issues. Given that no solution for participation could be found for these cases, which account for almost half of documented non-participation, we must infer that our sample exhibits bias in these areas compared to the overall centenarian population. In two additional cases, centenarians could not participate because they did not speak a Swiss national language (i.e., French, German, or Italian). Proxy informants either provided complementary information about the centenarian or participated when centenarians were unable to participate themselves. In total, we collected information from $N = 169$ centenarians living in 22 different cantons. This included $n = 96$ centenarian self-reports and $n = 73$ reports from proxy informants who responded on behalf of the centenarian. In 34 cases, we also obtained proxy information that was complementary to centenarian self-reports.

PROCEDURE
All participants received a written invitation by mail. Following this, they were contacted by phone to schedule an interview in the case that they agreed to participate. These telephone interviews, lasting around 60 min, began with acquiring verbal informed consent and were recorded upon participant approval. For those with hearing impairments, a paper questionnaire and informed consent form were sent by mail, to be completed and returned in separate prepaid envelopes. Our approach aimed to be as inclusive as possible, accommodating participants with sensory or cognitive limitations.

Measures
Sociodemographic characteristics
In the current study, we included chronological age, sex, living situation, and education level. We

categorised living situation into two broad classes: 'Private', referring to centenarians residing in community settings, such as their own homes; and 'Institution', referring to centenarians living in institutionalised settings, such as nursing homes. As for education, we divided it into three categories: 'Primary' for centenarians who completed only primary school, 'Secondary' for those who additionally completed middle school and/or basic professional training, and 'Higher education' for those who completed high school or university.

Mental health conditions

Depressive symptomatology

To screen for depressive symptoms, we devised a short version of the Geriatric Depression Scale (GDS[31]) by selecting five items that were most adapted to our study context. This five-item version allowed us to keep telephone interviews brief, which was a necessity considering that our participants often experience sensory and cognitive impairments. Each included item was scrutinised thoroughly regarding its psychometric attributes and relevance for measuring depressive symptoms in our population, so as to provide an age-fair assessment of depressive symptoms. Comprehensive details on item selection and psychometric evaluation are available in Supplementary Material S1. The five items required dichotomous (yes = 1, no = 0) answers to the following questions: 'Do you feel that your life is empty?', 'Do you often get bored?', 'Do you often feel helpless?', 'Do you feel that your situation is hopeless?', and 'Have you often felt dejected or sad?' Internal consistency for this abbreviated scale in our study was adequate, with a Cronbach's alpha of 0.70 ($n = 150$), similar to what was reported in prior research.[32,33] We combined the responses to the five items into a sum score, with a maximal score of five points, with higher scores indicating more depressive symptoms. We subsequently used a cut-off of two or more depressive symptoms to indicate whether or not centenarians had potentially clinically relevant depressive symptomatology, following proposals for other five-item GDS versions.[34]

Neuropsychiatric Inventory items

Focusing on the key domains of the Neuropsychiatric Inventory (NPI; Cummings[35]), we assessed the presence (yes = 1, no = 0) of the following four conditions with one single item each: anxiety (specified in the item description as feeling nervous, worried, frightened), sleep disturbance (difficulty sleeping, up at night), disinhibition (impulsive behaviour), and aberrant motor behaviour (pacing, opening closets). All four questions were answered by proxy informants, with 'anxiety' and 'sleep disturbances' also being self-assessed by the centenarians. These four NPI items were considered as separate domains in our study.

Cognitive status

As an indicator of cognitive status, we used an evaluation of recent memory. With centenarian self-reports, we based this on the recall item from the Mini-Mental State Examination (item 13, MMSE[36]), in which participants have to correctly recall three words (e.g., apple, table, penny) after having previously been asked to repeat them. When relying on proxy informant reports, we asked the proxy the following question: 'Can she/he recall recent events?' (yes = 1, no = 0). We considered cognitive status to be impaired when the centenarian was unable to correctly recall at least one word, or when the proxy indicated that the centenarian is unable to recall recent events.

Combination of centenarian and proxy reports

There were 34 cases for which we obtained both a centenarian self-report and a proxy informant report. Based on these data, Supplementary Material S2 presents an analysis comparing the agreement between the self-reports of the centenarians and the corresponding proxy informant reports. This is especially interesting when comparing centenarian and proxy reports concerning items that are typically only asked of caretakers, such as the anxiety and sleep disturbance items from the NPI. Moreover, this analysis informs our approach to combine centenarian and proxy reports in case of missing data. See Supplementary Material S3 for more details on missing data and how centenarian and proxy information was combined to complete information. When we had a report from both the centenarian and a proxy informant, we used the proxy informant report to fill in missing data and provide information on disinhibition and aberrant motor behaviour.

Data analysis

We conducted our statistical analysis utilising a Bayesian approach as advocated by Van Doorn et al.,[37] using JASP version 0.18.1. This method not only quantifies evidence for observed effects, but also differentiates between evidence supporting the absence of an effect and inconclusive evidence. This distinction is useful given potential limitations in our sample size, which might render some small effects undetectable. Bayes factors (BFs) between 1/3 and 3 were considered inconclusive. BFs from 1/10 to 1/3 or 3 to 10 indicated substantial evidence, while BFs <1/10 or >10 signified strong evidence. For all our analyses, we used non-informative priors to maintain neutrality, thereby not considering pre-existing knowledge, and letting our inferences be driven by our data. After reporting sample characteristics, we investigated the prevalence of mental health conditions and their interrelations. We computed Pearson correlation coefficients and quantified evidence for correlations with Bayesian correlation analysis using a non-informative stretched beta prior (*width* = 1). Then, we conducted a Bayesian logistic regression for each mental health condition, entering the following statistical predictors: source (i.e., centenarian or proxy), COVID-19 period (i.e., during protective measures or after), sociodemographic characteristics (i.e., age, sex, education level, living situation), and cognitive status (i.e., impaired, or not impaired). Once again, we used a non-informative prior, more specifically a g-prior with $\alpha = 3$ for the coefficients, and a model prior specified as Bernoulli with $P = 0.5$, indicating that any given predictor had an equal likelihood of being included or excluded from the model. The best model was determined by the highest posterior probability given the data. We reported BFs quantifying evidence for the best model compared to the null model, as well as the Bayesian R^2 as a measure of fit. We considered the evidence for inclusion of each predictor in the best model.

RESULTS

Sample description

The participants averaged 101.77 years in age (SD = 1.72), with a majority of women (75.15%). Nearly half (48.13%) of the participants indicated secondary education as their highest education level.

Almost two-thirds (63.91%) resided in long-term care facilities, and 43.31% had an impaired cognitive status. Table 1 details the sample characteristics. Of the 73 proxy information reports, the majority were provided by children of the centenarian (67.1%); followed by formal caregivers, such as nurses (13.7%); nieces or nephews (9.6%); grandchildren (2.7%); a spouse (1.4%); a friend (1.4%); and for 4.1% the relationship type was missing.

## Prevalence and interrelation of mental health conditions

In our sample of centenarians, 68.64% of participants reported experiencing at least one mental health condition. Among these, 40.83% experienced two or more mental health issues, 17.16% had three or more, and 3.55% reported over four conditions. As shown in Fig. 1, the most prevalent issue was depressive symptomatology (44.51%), closely followed by anxiety (42.17%). Sleep disturbances (29.88%) and disinhibition (17.31%) came next, with aberrant motor behaviour (10.28%) being the least frequently reported.

Bayesian correlation analysis yielded strong evidence for the association between depressive symptomatology and anxiety ($r = 0.45$, $BF_{01} = 1.94 \times 107$).

Table 1 Sample characteristics

Variables	Count	%
Source		
Centenarian self-report	96	56.80
Proxy informant report	73	43.20
COVID-19 period		
During protective measures	85	56.67
After protective measures	83	43.33
Sex		
Female	127	75.15
Male	42	24.85
Education level		
Primary	31	19.38
Secondary	77	48.13
Higher education	52	32.5
Living situation		
Private	61	36.09
Institution	108	63.91
Cognitive status		
Impaired	55	43.31
Not impaired	72	56.69

Note: Missing values: COVID-19 period (*n* = 1), Education level (*n* = 9), Cognitive status (*n* = 42). The missing values for impaired cognitive status are due to the fact that we could not administer a memory test to centenarian participants who filled in a paper questionnaire and a number of participants refused cognitive testing.
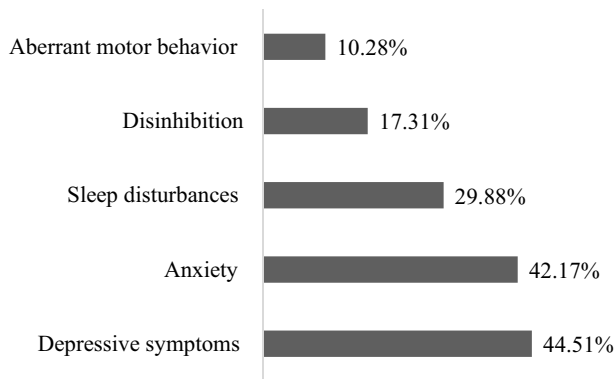
Figure 1 Prevalence of mental health conditions. Missing values: depressive symptoms ($n = 5$), anxiety ($n = 3$), sleep disturbances ($n = 5$), disinhibition ($n = 3$). Note that only proxy informants were asked about disinhibition and aberrant motor behaviour. For 34 participants in the centenarian self-report group, we obtained these data from their proxies. The final number of participants for each calculation of prevalence was as follows: depressive symptomatology ($n = 164$), anxiety ($n = 166$), sleep disturbances ($n = 164$), disinhibition ($n = 104$), aberrant motor behaviour ($n = 107$).

Bayesian analysis also yielded substantial evidence for the association between disinhibition and aberrant motor behaviour ($r = 0.28$, $BF_{01} = 7.72$). Furthermore, there was evidence against several correlations and some effects were inconclusive (see Table 2).

Statistical predictors of mental health conditions

For depressive symptomatology, the best model included sex, education level, and living situation ($n = 117$, $BF_{10} = 47.10$, $R^2 = 0.09$; Table 3). Table 3 shows there was strong evidence for the importance of living situation as a predictor of interindividual differences in depressive symptoms. Specifically, residing in an institution was associated with a 2.35-fold increase in the odds of experiencing depressive symptoms. Note that this effect was obtained while considering the cognitive status of the participants. Specifically, the present analyses were structured to assess the impact of each predictor while considering the influence of the others. Concerning the present analysis, inclusion of cognitive status and living situation among other predictors, allows us to account for the possibility that individuals living in nursing homes may be more cognitively impaired. Nevertheless, there was strong evidence for the effect of institutionalisation, but not for cognitive status. Because there was no evidence supporting the inclusion of cognitive status, it was not included in the final model.

By contrast, for anxiety, the best model included living situation and cognitive status ($n = 119$, $BF_{10} = 4.73$, $R^2 = 0.05$). However, as can be seen in Table 3, evidence specifically supporting the inclusion of living situation and cognitive status was inconclusive.

For sleep disturbances, the best model included COVID-19 period, education level, and cognitive status ($n = 116$, $BF_{10} = 289.24$, $R^2 = 0.14$). As can be seen in Table 3, evidence for the inclusion of education level was strong and evidence for the inclusion of cognitive status was substantial. Higher education level was associated with a 1.85-fold increase in the odds of experiencing sleep disturbances. Similarly, the absence of impaired cognitive status raised the odds of sleep disturbances 2.22 times.

For disinhibition, the best model included information source, COVID-19 period, education level, and cognitive status ($n = 92$, $BF_{10} = 15.41$, $R^2 = 0.15$).

Table 2 Bayesian Pearson correlations between mental health conditions

Variables	n	r	BF_{10}	95% CI
Depressive symp. - Anxiety	163	0.46	**1.94×10^7**	[0.329, 0.572]
Depressive symp. - Sleep disturbances	160	0.18	1.45	[0.029, 0.327]
Depressive symp. - Disinhibition	101	0.08	**0.16**	[−0.121, 0.263]
Depressive symp. - Aberrant mot. beh.	104	0.04	**0.13**	[−0.154, 0.226]
Anxiety - Sleep disturbances	162	0.18	1.15	[0.021, 0.318]
Anxiety - Disinhibition	104	0.19	0.75	[−0.005, 0.363]
Anxiety - Aberrant mot. beh.	107	0.05	**0.14**	[−0.143, 0.231]
Sleep disturbances - Disinhibition	100	0.09	**0.19**	[−0.107, 0.278]
Sleep disturbances - Aberrant mot. beh.	103	−0.12	**0.24**	[−0.298, 0.079]
Disinhibition - Aberrant mot. beh.	104	0.28	**7.72**	[0.092, 0.445]

Note: When the Bayesian evidence indicated the presence ($BF_{10} > 3$) or absence of an effect ($BF_{10} < 3$), the corresponding Bayes factor (BF) is highlighted in bold. Any effects for which the BF is not marked in bold were inconclusive. Abbreviations: Symp., symptoms; Aberrant mot. beh., aberrant motor behaviour.

Table 3 Bayesian logistic regression analyses: odds ratio (OR) and corresponding 95% CI, calculated from log odds

Variables	P(incl | data)	BF_{incl}	OR	95% CI
Depressive symptoms (n = 156)				
Intercept	1	1	0.61	[0.12, 2.55]
Sex	0.50	0.99	1.22	[0.79, 2.50]
Education level	0.70	2.33	0.78	[0.47, 1.01]
Living situation	0.97	**36.19**	2.35	[0.79, 3.81]
Anxiety (n = 126)				
Intercept	1	1	0.66	[0.28, 1.68]
Living situation	0.66	1.94	1.45	[0.86, 3.22]
Cognitive status	0.58	1.36	0.77	[0.36, 1.84]
Sleep (n = 116)				
Intercept	1	1	0.04	[0.01, 1.06]
COVID-19 period	0.68	2.10	0.65	[0.25, 1.09]
Education level	0.92	**10.74**	1.85	[1.00, 2.25]
Cognitive status	0.87	**6.63**	2.22	[1.00, 2.18]
Disinhibition (n = 92)				
Intercept	1	1	1.71	[0.18, 1.81]
Source	0.72	2.57	0.49	[0.12, 1.63]
COVID-19 period	0.49	0.96	0.77	[0.24, 0.77]
Education level	0.52	1.08	0.80	[0.36, 1.27]
Cognitive status	0.91	**10.11**	0.30	[0.14, 1.32]
Aberrant motor behaviour (n = 100)				
Intercept	1	1	7.4×10^{-10}	[0, 1.15]
Age	0.64	1.79	1.15	[0.01, 1.15]
Cognitive status	0.95	**18.41**	0.18	[0.04, 1.19]

Note: The reference level of the binary predictors was as follows: Information source = centenarian, COVID-19 period = after, sex = male, living situation = home, cognitive status = impaired. When the Bayesian evidence indicated the presence ($BF_{10} > 3$) or absence of an effect ($BF_{10} < 3$), the corresponding Bayes factor (BF) ss highlighted in bold. Any effects for which the BF is not marked in bold were inconclusive.

Table 3 shows that there was strong evidence for the inclusion of cognitive status. The absence of impaired cognitive status lowered the odds of disinhibition by a factor of 0.30.

Finally, for aberrant motor behaviour, the best model included age and cognitive status ($n = 93$, $BF_{10} = 27.40$, $R^2 = 0.17$). Table 3 indicates that there was strong evidence for the inclusion of cognitive status. The absence of impaired cognitive status lowered the odds of aberrant motor behaviour by a factor of 0.18.

DISCUSSION

Our study sought to investigate mental health conditions among centenarians in Switzerland. We aimed to determine the prevalence of the most important mental health conditions in very old age and to identify statistical predictors of individual variations in these conditions, serving as either risk or protective factors, with implications for the development of targeted interventions. In our sample, 68.64% of centenarians reported at least one mental health condition, 40.83% two or more, and 17.16% three or more. Noteworthy, almost a third of our sample (31.36%) did not present any mental health conditions at all, underscoring the diversity inherent in the oldest old population.

The pattern of results showed similarities with the study of Mall et al.,[15] which found that the most prevalent mental health issue was depressive symptomatology (65%), followed by anxiety (52%). This was also the case in our study, with depressive symptoms appearing most frequently (44.51%), closely followed by anxiety (42.17%). Our sample had a lower prevalence of these conditions compared to Mall et al.,[15] which could be due to the fact that this prior research included an institutionalised sample with a high prevalence of cognitive impairment (67%). For comparison, our sample contained 63.91% of centenarians in institutions and the prevalence rate of cognitive impairment was 43.31%.

Compared to centenarians in other countries,[3] our centenarian sample showed a higher prevalence of depressive symptoms and anxiety. For example, the prevalence of depressive symptoms surpassed that of Portugal (35%), while the anxiety rates were comparable to those of Portuguese centenarians (45%).

Simultaneously, our findings on depression and anxiety align with research suggesting a higher prevalence of mental health conditions in centenarians than in younger senior groups.[12] Much lower prevalence rates have been found in younger older individuals, including 15.6% for affective disorders such as depression and 7.8% for anxiety disorders in Swiss adults aged 65 to 84 years.[7]

Compared to other centenarian studies, the higher prevalence of depressive symptoms and anxiety in our sample could be due to country-specific factors (e.g., social support structure, perception of ageing in society), sample composition (e.g., degree of institutionalisation, which is particularly important for depressive symptoms), or other contextual factors. One possible contextual factor is that half of our participants were interviewed during a period with stringent COVID-19 protective measures. The prevalence of depressive symptoms was 46.34% during this time, compared to 41.98% afterward, while anxiety rates were 42.17% during versus 41.46% after. Bayesian logistic regression yielded inconclusive evidence against an impact of the COVID-19 period on depressive symptoms ($BF_{incl} = 0.518$) and anxiety ($BF_{incl} = 0.517$), which does not allow us to firmly dispel an effect. It is possible that the experience of the COVID-19 pandemic had long-lasting effects on mental health.

Our results revealed interrelations between different mental health conditions, suggesting the potential co-occurrence of these conditions or overlapping manifestations. Notably, depressive symptoms were linked to anxiety, which Balsamo *et al.*[26] also found in younger older adults (55–89 years); and disinhibition was linked to aberrant motor behaviour. This highlights the need for comprehensive assessment and treatment approaches in centenarians that consider the co-occurrence of mental health conditions, which may exacerbate daily life impairments and present additional treatment challenges.[29]

Our Bayesian analysis yielded strong evidence that institutionalised living increased the odds of depressive symptomatology. This is in line with past studies showing the impact of institutional settings on mental health,[10,20,23] which may be due to factors such as reduced independence and family network. Alternatively, depressive symptomatology might increase the odds of being placed in an institution. While our study design does not allow us to establish causality to distinguish between these possibilities, it could be that depressed individuals may feel less able to take care of themselves, and this might expedite their placement.

Interestingly, our analysis yielded evidence that a higher education level and the absence of cognitive impairment increased the odds of sleep disturbances. These characteristics might lead individuals to be more mentally active at night, potentially causing sleep issues, or it might reflect their greater attentiveness and reporting of sleep-related problems. The relationship between higher education, preserved cognitive function, and sleep disturbances warrants further exploration.

Finally, our Bayesian analysis yielded strong evidence suggesting that cognitive impairment increased the odds of both disinhibition and aberrant motor behaviour. This association may be attributed to the deterioration of executive control processes, which are critical for regulating actions and behaviour.[38,39] Future studies should explore cognitive aspects beyond memory, to better isolate executive control processes that may be impaired and therefore contribute to disinhibition and aberrant motor behaviour.

STRENGTHS AND LIMITATIONS

Our study provides unique data on mental health in very old individuals by focusing on centenarians, an age group often overlooked in typical ageing research. We collected data nationwide, including nearly all cantons and the three primary linguistic regions of Switzerland. Notably, our approach not only incorporated responses provided by the centenarians themselves but also from proxy representatives. Despite their crucial role in centenarian care, the invaluable perspective of these informants is frequently underutilised. Broadening our scope beyond depressive symptoms and anxiety, our research also included lesser-studied aspects of mental health, such as sleep disturbances, disinhibition, and aberrant motor behaviour.

It is also essential to recognise the limitations of the current study. Due to its cross-sectional design, we cannot ascertain causal relationships or track temporal shifts. A longitudinal approach would better elucidate causality and the progression of changes. Furthermore, we based the cognitive status on a single item related to memory, which gives a very

limited indication of cognitive functioning. Next, the study methodology, reliant on self-reports and proxy informants, may introduce bias.[40] Another source of bias is the fact that cognitive, hearing, and health impairments contributed to many individuals not being able to participate in the study, when no solution could be found. Therefore, our sample likely presents better cognitive, sensory, and health functioning than the larger centenarian population. Based on our observations of the effect of cognitive impairment on mental health issues, we surmise that the population prevalence of sleep disturbances could be lower than what is reported in this study, while the true prevalence of disinhibition and aberrant motor behaviour could be higher. Individuals could potentially under-report or misreport symptoms, and proxy informants may not fully comprehend or accurately convey the centenarians' mental health conditions. Additionally, incorporating participants with cognitive impairments could affect report reliability. In cases where centenarians exhibited cognitive impairment, we frequently relied on proxy informants. This approach led to multicollinearity between cognitive impairment and information source. Nonetheless, in our logistic regression analyses, cognitive impairment was often retained as a predictor, whereas we did not find evidence for the role of information source. Lastly, we collected our data amid the COVID-19 pandemic and its aftermath, which might have had a lasting impact on the mental health of our participants.

Nevertheless, this study provides a first insight into the mental health of centenarians in Switzerland. Our ongoing research will allow us to contrast our current results with those from ongoing in-person interviews for a more detailed and longitudinal assessment. For instance, we will be able to link mental health issues to prescriptions for medications that target anxiety, depression, and sleeping disorders, which was not possible in this telephone study.

CONCLUSION

In conclusion, this study reveals important insights into the prevalence of mental health conditions among centenarians living in Switzerland. It underscores that mental health conditions, particularly depressive symptoms, and anxiety, are highly prevalent in the oldest old, thereby highlighting the need for proactive mental health care strategies in this age group. Our findings indicate the need for targeted support for certain groups that may be particularly vulnerable to these conditions, such as those living in institutional settings. The findings should serve as a call to action for policymakers, mental health professionals, and caregivers to consider the unique mental health needs of the oldest members of our society.

DISCLOSURE

The authors declare no conflict of interests for this article.

DATA AVAILABILITY STATEMENT

The data supporting the findings of this study are not openly accessible, in compliance with the data sharing policies agreed upon by the study participants. However, Prof. Dr. Daniela Jopp (daniela.jopp@unil.ch) can provide access to the data upon receiving a reasonable request.

REFERENCES

1 Teixeira L, Araújo L, Jopp DS, Ribeiro O. Centenarians in Europe. *Maturitas* 2017; **104**: 90–95.
2 Federal Statistical Office. *Living to 100 Years and beyond*, 2022. https://www.bfs.admin.ch/bfs/en/home/statistics/population/ageing/centenarians.html.
3 Cheng A, Leung Y, Harrison F, Brodaty H. The prevalence and predictors of anxiety and depression in near-centenarians and centenarians: a systematic review. *Int Psychogeriatr* 2019; **31**: 1539–1558.
4 Ribeiro O, Teixeira L, Araújo L, Rodríguez-Blázquez C, Calderón-Larrañaga A, Forjaz MJ. Anxiety, depression, and quality of life in older adults: trajectories of influence across age. *Int J Environ Res Public Health* 2020; **17**: 9039.
5 Savage S, Bailey S. The impact of caring on caregivers' mental health: a review of the literature. *Aust Health Rev* 2004; **27**: 111.

6 Bai X. Images of ageing in society: a literature review. *J Popul Ageing* 2014; **7**: 231–253.

7 Andreas S, Schulz H, Volkert J *et al*. Prevalence of mental disorders in elderly people: the European MentDis_ICF65+ study. *Br J Psychiatry* 2017; **210**: 125–131.

8 Fässberg MM, Östling S, Börjesson-Hanson A, Skoog I, Wærn M. Suicidal feelings in the twilight of life: a cross-sectional population-based study of 97-year-olds. *BMJ Open* 2013; **3**: e002260.

9 Ribeiro O, Teixeira L, Araújo L, Afonso RM, Pachana N. Predictors of anxiety in centenarians: health, economic factors, and loneliness. *Int Psychogeriatr* 2015; **27**: 1167–1176.

10 Tafaro L, Cicconetti P, Zannino G *et al*. Depression and aging: a survival study on centenarians. *Arch Gerontol Geriatr* 2002; **35**: 371–376.

11 Ribeiro O, Duarte N, Teixeira L, Paul C. Frailty and depression in centenarians. *Int Psychogeriatr* 2018; **30**: 115–124.

12 Bergdahl E, Gustavsson JMC, Kallin K *et al*. Depression among the oldest old: the Umea 85+ study. *Int Psychogeriatr* 2005; **17**: 557–575.

13 Cohen-Mansfield J, Shmotkin D, Blumstein Z *et al*. The old, old-old, and the oldest old: continuation or distinct categories? An examination of the relationship between age and changes in health, function, and wellbeing. *Int J Aging Hum Dev* 2013; **77**: 37–57.

14 Dello Buono M, Urciuoli O, De Leo D. Quality of life and longevity: a study of centenarians. *Age Ageing* 1998; **27**: 207–216.

15 Mall JF, Chouiter L, Antonietti JP, Ebbing K, von Gunten A. Cognition and psychopathology in nonagenarians and centenarians living in geriatric nursing homes in Switzerland: a focus on anosognosia. *Psychogeriatrics* 2014; **14**: 55–62.

16 Pires GN, Ishikura IA, Xavier SD *et al*. Sleep in older adults and its possible relations with COVID-19. *Front Aging Neurosci* 2021; **13**: 647–875.

17 Burley CV, Burns K, Brodaty H. Pharmacological and non-pharmacological approaches to reduce disinhibited behaviors in dementia: a systematic review. *Int Psychogeriatr* 2022; **34**: 335–351. https://doi.org/10.1017/S1041610222000151.

18 Chapman KR, Spitznagel MB. Measurement of sexual disinhibition in dementia: a systematic review. *Int J Geriatr Psychiatry* 2019; **34**: 1747–1757. https://doi.org/10.1002/gps.5208.

19 Davey A, Dai T, Woodard JL *et al*. Profiles of cognitive functioning in a population-based sample of centenarians using factor mixture analysis. *Exp Aging Res* 2013; **39**: 125–144.

20 Freeman S, Armstrong JJ, Tyas SL, Neufeld E. Clinical characteristics and patterns of health deficits of centenarians receiving home care and long-term care services. *Exp Gerontol* 2017; **99**: 46–52.

21 Jopp DS, Park M-KS, Lehrfeld J, Paggi ME. Physical, cognitive, social and mental health in near-centenarians and centenarians living in New York City: findings from the Fordham centenarian study. *BMC Geriatr* 2016; **16**: 1.

22 Kato K, Zweig R, Schechter CB, Barzilai N, Atzmon G. Positive attitude toward life, emotional expression, self-rated health, and depressive symptoms among centenarians and near-centenarians. *Aging Ment Health* 2016; **20**: 930–939.

23 Margrett J, Martin P, Woodard JL *et al*. Depression among centenarians and the oldest old: contributions of cognition and personality. *Gerontology* 2010; **56**: 93–99.

24 Toyoshima A, Martin P, Sato S, Poon LW. The relationship between vision impairment and well-being among centenarians: findings from the Georgia centenarian study. *Int J Geriatr Psychiatry* 2018; **33**: 414–422.

25 Wolitzky-Taylor KB, Castriotta N, Lenze EJ, Stanley MA, Craske MG. Anxiety disorders in older adults: a comprehensive review. *Depress Anxiety* 2010; **27**: 190–211.

26 Balsamo M, Cataldi F, Carlucci L, Fairfield B. Assessment of anxiety in older adults: a review of self-report measures. *Clin Interv Aging* 2018; **13**: 573–593.

27 Ganidagli S, Ozturk E, Ozturk ZA. Risk factors of poor sleep quality in older adults: an analysis based on comprehensive geriatric assessment. *Curr Med Res Opin* 2023; **39**: 701–706. https://doi.org/10.1080/03007995.2023.2192124.

28 Xiao S, Shi L, Zhang J *et al*. The role of anxiety and depressive symptoms in mediating the relationship between subjective sleep quality and cognitive function among older adults in China. *J Affect Disord* 2023; **325**: 640–646. https://doi.org/10.1016/j.jad.2023.01.048.

29 Newman DL, Moffitt TE, Caspi A, Silva PA. Comorbid mental disorders: implications for treatment and sample selection. *J Abnorm Psychol* 1998; **107**: 305–311.

30 Jopp DS, Cavalli S, von Gunten A, Herrmann F. *Swiss Centenarian Study (SWISS100): Vulnerability and Resilience at Age 100*. Bern: Swiss National Science Foundation, 2019.

31 Sheikh JI, Yesavage JA. Geriatric depression scale (GDS): recent evidence and development of a shorter version. *Clin Gerontol* 1986; **5**: 165–173.

32 Hoyl MT, Alessi CA, Harker JO *et al*. Development and testing of a five-item version of the geriatric depression scale. *J Am Geriatr Soc* 1999; **47**: 873–878.

33 Van Marwijk HW, Wallace P, de Bock GH, Hermans J, Kaptein AA, Mulder JD. Evaluation of the feasibility, reliability and diagnostic value of shortened versions of the geriatric depression scale. *Br J Gen Pract* 1995; **45**: 195–199.

34 Rinaldi P, Mecocci P, Benedetti C *et al*. Validation of the five-item geriatric depression scale in elderly subjects in three different settings. *J Am Geriatr Soc* 2003; **51**: 694–698.

35 Cummings JL, Mega M, Gray K, Rosenberg-Thompson S, Carusi DA, Gornbein J. The neuropsychiatric inventory: comprehensive assessment of psychopathology in dementia. *Neurology* 1994; **44**: 2308–2314.

36 Folstein MF, Folstein SE, McHugh PR. Mini-mental state: a practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res* 1975; **12**: 189–198.

37 van Doorn J, van den Bergh D, Böhm U *et al*. The JASP guidelines for conducting and reporting a Bayesian analysis. *Psychon Bull Rev* 2021; **28**: 813–826.

38 Knutson KM, Dal Monte O, Schintu S *et al*. Areas of brain damage underlying increased reports of behavioral disinhibition. *J Neuropsychiatry Clin Neurosci* 2015; **27**: 193–198.

39 Nagata T, Shinagawa S, Ochiai Y *et al*. Relationship of frontal lobe dysfunction and aberrant motor behaviors in patients with Alzheimer's disease. *Int Psychogeriatr* 2010; **22**: 463–469.

40 Neumann PJ, Araki SS, Gutterman EM. The use of proxy respondents in studies of older adults: lessons, challenges, and opportunities. *J Am Geriatr Soc* 2000; **48**: 1646–1654.

SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article at the publisher's website: http://onlinelibrary.wiley.com/doi//suppinfo.

Data S1. Supporting information.
Data S2. Supporting information.
Data S3. Supporting information.