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Original Research

Self-management and hospitalization in 615 Swedish patients with Addison's disease during the coronavirus disease 2019 pandemic: a retrospective study

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Abstract

Objective: Autoimmune Addison's disease (AAD) entails a chronic adrenal insufficiency and is associated with an increased risk of severe infections. It is, however, unknown how patients with AAD were affected by the coronavirus disease 2019 (COVID-19) pandemic of 2020-2021. This study was aimed at investigating the incidence of COVID-19 in patients with AAD in Sweden, the self-adjustment of medications during the disease, impact on social aspects, and treatment during hospitalization. Additionally, we investigated if there were any possible risk factors for infection and hospitalization.

Design and methods: Questionnaires were sent out from April to October 2021 to 813 adult patients with AAD in the Swedish Addison Registry. The questionnaires included 55 questions inquiring about COVID-19 sickness, hospital care, medications, and comorbidities, focusing on the pre-vaccine phase.

Results: Among the 615 included patients with AAD, COVID-19 was reported in 17% of which 8.5% required hospital care. Glucocorticoid treatment in hospitalized patients varied. For outpatients, 85% increased their glucocorticoid dosage during sickness. Older age ($P = .002$) and hypertension ($P = .014$) were associated with an increased risk of hospital care, while younger age ($P < .001$) and less worry about infection ($P = .030$) were correlated with a higher risk of COVID-19.

Conclusions: In the largest study to date examining AAD during the COVID-19 pandemic, we observed that although one-fifth of the cohort contracted COVID-19, few patients required hospital care. A majority of the patients applied general recommended sick rules despite reporting limited communication with healthcare during the pandemic.

Keywords: COVID-19, adrenal insufficiency, autoimmune Addison's disease, self-management

Significance

Adrenal insufficiency is considered to be associated with an increased infection rate and subsequent severe disease, but a comprehensive study of COVID-19 in patients with AAD has not yet been reported. This questionnaire-based study including 615 patients with AAD is the largest in this patient group and provides a unique insight into self-management. We found that although many participants contracted COVID-19, few of them required hospital care. Many reported not receiving any information about COVID-19 from healthcare, yet a majority of patients increased their glucocorticoid medication dosages during COVID-19 in line with general sick rules for adrenal insufficiency. No increase in the frequency of adrenal crises during the pandemic compared with previous years was found.

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Introduction

The most common cause of primary adrenal insufficiency (PAI) in adults is autoimmune Addison's disease (AAD).[1] More than half of the patients with AAD have additional autoimmune disorders, usually in the form of autoimmune polyendocrine syndrome type 2 (APS2).[2] Autoimmune polyendocrine syndrome type 1 (APS1) with an estimated prevalence of 1 in 90 000 individuals is far less common than APS2.[3] Clinical diagnosis of APS1 is set if at least two of the following disorders are present in a patient: AAD, chronic mucocutaneous candidiasis, and hypoparathyroidism.[4]

During intercurrent illness such as infections, surgery and trauma patients with AAD are at risk of adrenal crisis, a life-threatening condition with an estimated prevalence of 5.2-8.3 per 100 patient-years and a mortality rate of 1 per 200 patient-years.[5,6] In case of an adrenal crisis prompt treatment with stress doses of intravenous hydrocortisone and fluids are lifesaving. Adrenal insufficiency patients should carry a medical alert card and have good knowledge about glucocorticoid dose adjustments in case of intercurrent illnesses.[7]

Coronavirus disease 2019 (COVID-19) is caused by a virus named severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). It was discovered in 2019 in Wuhan, China and caused a pandemic within 3 months.[8] People with hypertension, diabetes, immunosuppression, malignancy, older age, obesity, and/or male sex have an increased risk of severe SARS-CoV-2 infection.[9] The National Board of Health and Welfare in Sweden declared in June 2020 that adrenal insufficiency entails a risk of life-threatening deterioration in case of infection with SARS-CoV-2.[10] This allowed for individuals with adrenal insufficiency to apply for a temporary subsidy and work from home if it was not possible to keep social distancing at their workplace.[11] Vaccination against COVID-19 was offered to all risk group adults on a national level starting in May 2021.

Previous studies suggest that adrenal insufficiency is associated with an increased risk of hospitalization during infections[12] and that lower respiratory tract infections is up to nine times more common in patients with PAI.[13] Information on outcomes of COVID-19 in individuals with AAD, however, is scarce. Studies have aimed to investigate whether the frequency of adrenal crises increased during the pandemic or if the quality of life was reduced,[14,15] while others looked at the incidence of COVID-19 or symptoms in this group compared with controls.[16,17] But these studies have either been done during the early phase of the COVID-19 pandemic when testing was not widely available, had a low number of patients with AAD in their study or did not have sufficient cases of COVID-19 in their cohort to draw any certain conclusions. The few cases that have been reported in APS1 indicate that the diagnosis is associated with severe illness in case of COVID-19.[18]

This study focuses on Swedish patients with AAD enduring the COVID-19 pandemic. The aims were to investigate the incidence of COVID-19, the self-adjustment of medications, impact on social aspects as well as the necessity of hospital care and treatment during hospitalization. Possible risk factors for infection and hospitalization were also investigated.

Materials and methods

This study is a multicenter retrospective cohort study using questionnaires sent to adult patients with AAD included in the Swedish Addison registry from April to October of 2021. The Swedish Addison registry contains information about date of diagnosis, comorbidities, medications, heredity, immunological, and genetic data of more than 1000 individuals with AAD from all over Sweden.[19] The questionnaire was composed of 55 questions covering eventual COVID-19 sickness, confirmation of diagnosis with PCR or antibody-testing, hospital care, symptoms, medications, comorbidities, number of previous adrenal crises, possibility to work from home, information received from healthcare, received temporary subsidy, and worry about COVID-19 (Table S1). Reminders were sent out twice with a 1-2-months interval. If answers in the questionnaire needed clarification, the patient was contacted by phone. The medical records of patients admitted to hospital with COVID-19 were systematically reviewed. Patients with AAD infected or hospitalized for COVID-19 were compared with those who were not regarding age, sex, medications, comorbidities, worry about infection, and previous adrenal crises.

This study was performed in line with the declaration of Helsinki and approved by the Swedish Ethical Review Authority with approval number 2021-00448. Written informed consent was obtained from all patients.

Statistics

Statistics were performed using SPSS version 27.0 (IBM Corp. 2020, Armonk, NY). Continuous variables were described with mean and standard deviation (SD) in case of normal distribution and median and interquartile range (IQR) otherwise. Independent *t*-tests were used unless any of the assumptions for the test was violated upon which Mann–Whitney *U* test was used instead. Categorical variables were described with percentages (%) and analyzed using chi-square tests and Fisher's two-tailed exact tests. A comparison of the number of adrenal crises before and after the pandemic was performed using a paired *t*-test. Any "don't know" answers in the questionnaire were excluded. *P*-values <.05 were considered significant. When comparing different glucocorticoid medications, the following equivalent dosage calculations were used:[19]

$$Hydrocortisone \times 1\ ;\ \ Cortisone\ acetate \times 0.8;$$
$$MRH \times 0.806;\ \ Prednisolone \times 4$$

Results

A total of 662 (81%) of the 813 questionnaires distributed to patients with AAD were returned of which 615 met the inclusion criteria (Figure 1). Out of the 615 individuals, 598 had non-APS1 AAD, referred to in this work as AAD, while 17 had APS1. The entire cohort consisted of 61.0% women. The median age was 58 years (range 18-89) in the AAD-group and 53 years (range 32-84) in the APS1-group. The baseline characteristics of participants are presented in Table 1. The median (IQR) basal therapy glucocorticoid dosage was 24 (20-30) mg day^{-1} in the entire cohort as well as in the AAD-group. The most common dosages in the AAD-group were 20, 30, and 25 mg day^{-1} (29%, 25%, and 14%, respectively) and the median glucocorticoid dosage was higher in men than in women (25 vs 20 mg day^{-1}, $P < .001$).

SARS-CoV-2 infection

COVID-19 was reported by 17% of the entire cohort, 87% of which was confirmed with a PCR- or antibody test. In total,

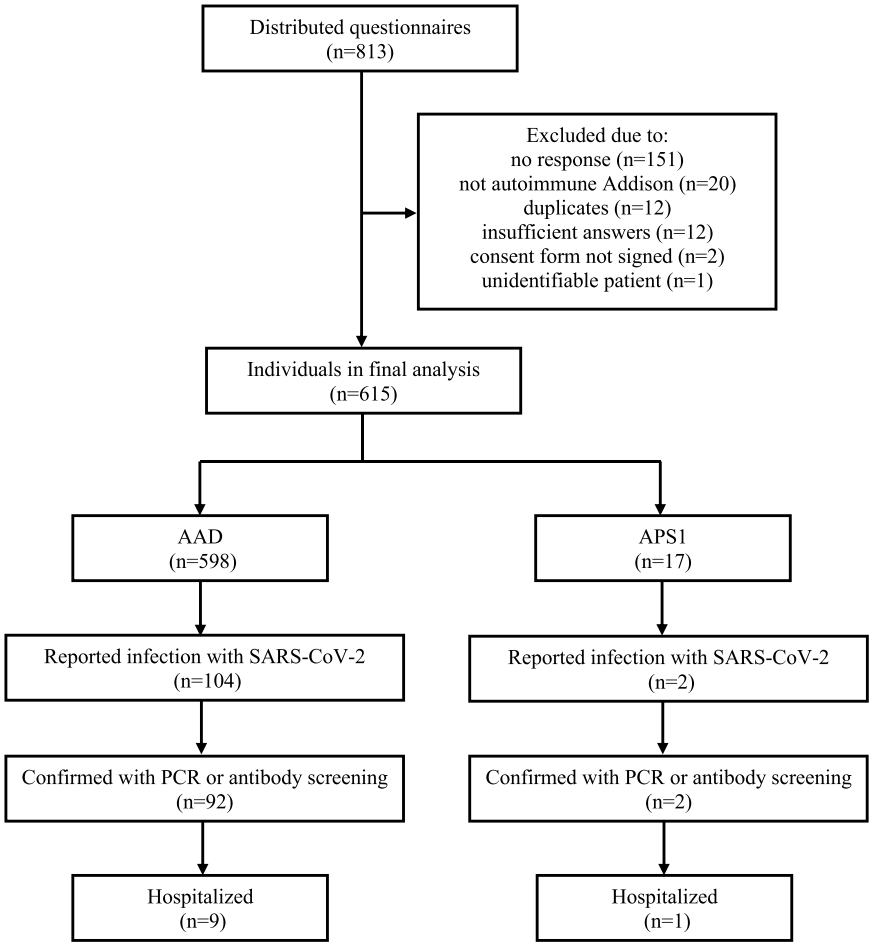

Figure 1. Flowchart of the distribution of questionnaires reported infections and hospitalizations.

Table 1. Baseline characteristics grouped by AAD and APS1.

Characteristics	Total ($n = 615$)	AAD ($n = 598$)	APS1 ($n = 17$)	*P*-value AAD vs APS1
Women, *n* (%)	375 (61.0)	366 (61.2)	9 (52.9)	.615
Age, median (range)	58 (18-89)	58 (18-89)	53 (32-84)	.313
21-OH-autoantibodies, *n* (%)	514 (83.6)	508 (84.9)	6 (35.3)	<.001
Comorbidities, *n* (%)				
Hypothyroidism	255 (41.5)	249 (41.6)	6 (35.3)	1.000
Diabetes mellitus type 1	75 (12.4)	69 (11.5)	6 (35.3)	.012
Diabetes mellitus type 2	41 (6.7)	40 (6.7)	1 (5.9)	1.000
Hypertension	135 (22.0)	126 (21.1)	9 (52.9)	.003
Previous acute coronary syndrome	15 (2.4)	13 (2.2)	2 (11.8)	.062
Previous stroke	12 (2.0)	11 (1.8)	1 (5.9)	.289
Asthma	5 (0.8)	5 (0.8)	0 (0.0)	1.000
Chronic obstructive pulmonary disease	13 (2.1)	12 (2.0)	1 (5.9)	.295
Medications, *n* (%)				
Hydrocortisone	506 (82.3)	493 (82.4)	13 (76.5)	.511
Modified release hydrocortisone	91 (14.8)	88 (14.7)	3 (17.6)	.729
Other glucocorticoid treatment[a]	14 (2.3)	13 (2.2)	1 (5.9)	.329
Fludrocortisone	553 (89.9)	540 (90.3)	13 (76.5)	.068
Levothyroxine	313 (50.9)	307 (51.3)	6 (35.3)	.224
Anti-hypertensive drugs	134 (21.8)	125 (20.9)	9 (52.9)	.004
Lipid-lowering drugs	133 (21.6)	127 (21.2)	6 (35.3)	.227
Medications against infections[b]	98 (15.9)	89 (14.9)	9 (52.9)	<.001
Other medications	385 (62.6)	373 (62.4)	12 (70.6)	.615

[a]Cortisone acetate, hydrocortisone pump, or prednisolone.
[b]Viral, bacterial and/or fungal infections during the past year.

Table 2. Risk factors for infection in the AAD-group.

Characteristics	COVID + ($n = 104$)	COVID − ($n = 494$)	*P*-value
Women, *n* (%)	67 (64.4)	299 (60.5)	.459
Age, median (range)	52 (22-87)	60 (18-89)	<.001
Comorbidities, *n* (%)			
Hypothyroidism	44 (42.3)	205 (41.5)	.897
Diabetes mellitus type 1	14 (13.5)	56 (11.3)	.540
Diabetes mellitus type 2	5 (4.8)	35 (7.1)	.519
Hypertension	8 (7.7)	118 (23.9)	<.001
Previous acute coronary syndrome	2 (1.9)	11 (2.2)	1.000
Previous stroke	2 (1.9)	9 (1.8)	1.000
Asthma	1 (1.0)	4 (0.8)	1.000
Chronic obstructive pulmonary disease	0 (0.0)	12 (2.4)	.139
Medications, *n* (%)			
Hydrocortisone	86 (82.7)	407 (82.4)	.928
Modified release hydrocortisone	16 (15.4)	72 (14.6)	.857
Other glucocorticoid treatment[a]	2 (1.9)	11 (2.2)	1.000
Fludrocortisone	95 (91.3)	445 (90.1)	.864
Levothyroxine	55 (52.9)	252 (51.0)	.728
Anti-hypertensive drugs	9 (8.7)	116 (23.5)	<.001
Lipid-lowering drugs	16 (15.4)	111 (22.5)	.113
Medications against infections[b]	18 (17.3)	71 (14.4)	.491
Other medications	60 (57.7)	313 (63.4)	.278

Includes cases not confirmed with PCR or antibody screening.
[a]Cortisone acetate, hydrocortisone pump, or prednisolone.
[b]Viral, bacterial and/or fungal infections during the past year.

9/615 (1.5%) of the participants reported hospital admission for COVID-19, that is, 8.5% of those reporting COVID-19 infection. Two patients with APS1 got COVID-19 confirmed with PCR and one of them required hospitalization (Figure 1). Persons in the AAD-group who contracted COVID-19 had a lower median age than those who did not ($P < .001$) with no difference regarding sex ($P = .46$), dosage of basal replacement therapy glucocorticoids ($P = .98$) or a history of at least one adrenal crises during the past 5 years ($P = .90$). There was no statistical difference between the mean number of adrenal crises during the past year in comparison to the previous 4 years ($P = .058$) based on self-reported data in the questionnaires. Hypertension and use of anti-hypertensive drugs in the AAD-group were less common among the AAD-patients who had been infected with SARS-CoV-2 ($P < .001$), no other differences regarding comorbidities and medications were found (Table 2). Exclusion of subjects without antibody- or PCR-confirmed infection ($n = 14$) did not alter these results.

The most commonly reported COVID-19 symptoms in the AAD-group were fatigue, headache, fever, and loss of smell and/or taste (88%, 70%, 67%, and 63%, respectively) (Table S2). Most patients in the AAD-group were sick in COVID-19 during 7-14 days (37%) or 3-7 days (31%, Figure 2A). During the infection, 85% in the AAD-group increased their glucocorticoid dosage (Figure 2B), mostly by doubling the maintenance dose (Figure 2C). Not increasing the glucocorticoid dosage was the most common approach in the group experiencing symptoms for less than 3 days (Figure 2C). The two APS1 patients who contracted COVID-19 reported disease durations longer than 14 days. One of them required intensive care whereas the other patient managed the infection at home with triple glucocorticoid dosage during the illness.

A majority in the AAD-group reported not receiving any information from healthcare regarding COVID-19 while a majority in the APS1-group reported receiving at least some information. About half of the total cohort aged ≤64 years worked from home at least partially. The temporary subsidy offered to risk groups was received by 8% in the cohort, all aged ≤64 years (Table S3). Worry about infection on a scale from 0 to 100 varied considerably in the AAD-group with a median (IQR) of 60 (30-80) (Figure 3). Women were more worried than men ($P < .001$) but there was no association between age and worry about infection when comparing those older than 65 years with those younger than 65 years ($P = .58$). Individuals with APS1 were more worried of SARS-CoV-2 infection than those in the AAD-group (median = 80, IQR; 50-90, $P = .028$). Those in the AAD-group who had already been ill with COVID-19 when answering the questionnaire were less worried of COVID-19 than those who had not contracted the disease ($P = .030$).

Hospital setting

Hospital care was required by nine patients including one individual with APS1. Seven people were hospitalized because of symptoms related to COVID-19, and the remaining two were admitted because of an adrenal crisis and an euglycemic ketoacidosis, respectively. SARS-CoV-2 infection was confirmed with PCR tests in all cases. Four of the patients were admitted for at least 2 weeks, whereas the remaining five were admitted for 3 days or less. Two in the AAD-group required intensive care as well as the individual with APS1. All patients were hospitalized before the start of vaccinations with five being admitted in early spring 2021.

Intravenous hydrocortisone was administered to eight of the nine patients upon arrival at the emergency room while only five persons received oxygen during admission. Double or triple oral hydrocortisone dosages, betamethasone either as the only treatment or in combination with the patients' usual basal therapy dosages and intravenous hydrocortisone either as a complement to the oral glucocorticoid treatment or as the only treatment were the different treatments used during hospitalization. The management of glucocorticoid medications differed vastly between cases as well as between days of care in individual cases.

Among the hospitalized non-APS1 AAD-patients, the median age was 16 years higher ($P = .002$) and diabetes mellitus type 2, hypertension, and previous acute coronary syndrome were more common in the hospitalized patients ($P = .047$, $P = .014$, and $P = .005$, respectively). In line with this, anti-hypertensive drugs and lipid-lowering drugs were more common in those requiring hospital care than among those who did not ($P = .002$ and $P = .002$, respectively). Among the hospitalized patients in the AAD-group 62% (5/8) used fludrocortisone compared with 94% in those not requiring hospital care ($P = .021$). However, upon exclusion of all subjects with anti-hypertensive drugs, the *P*-value no longer remained significant ($P = .233$). There was no discernible association between hospitalization and maintenance glucocorticoid dosage ($P = .098$). Table 3 compares comorbidities and medications of those in need and no need of hospital care during COVID-19 in the AAD-group. After exclusion of subjects without PCR-confirmation of SARS-CoV-2, all significant comparisons remained with a *P*-value <.05, except for diabetes mellitus type 2 ($P = .061$). Reported symptoms in the two groups were compared but no differences were found (Table S2).

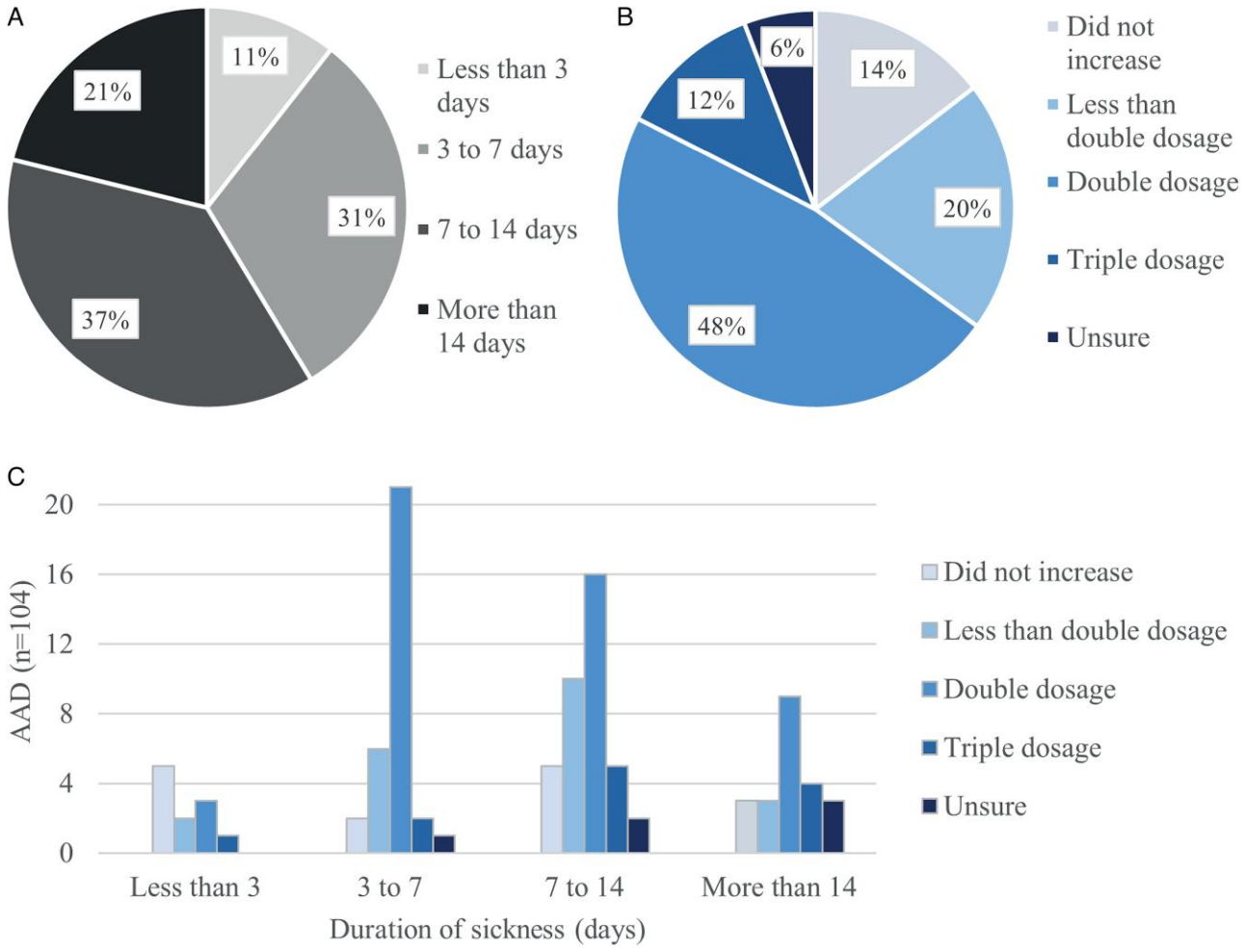

Figure 2. Duration of sickness and increase of glucocorticoid dosage in the AAD-group during infection. A, Duration of sickness with COVID-19 ($n = 104$). B, Increase of glucocorticoid dosage during sickness ($n = 104$). C, Increase of glucocorticoid dosage grouped by duration of sickness.

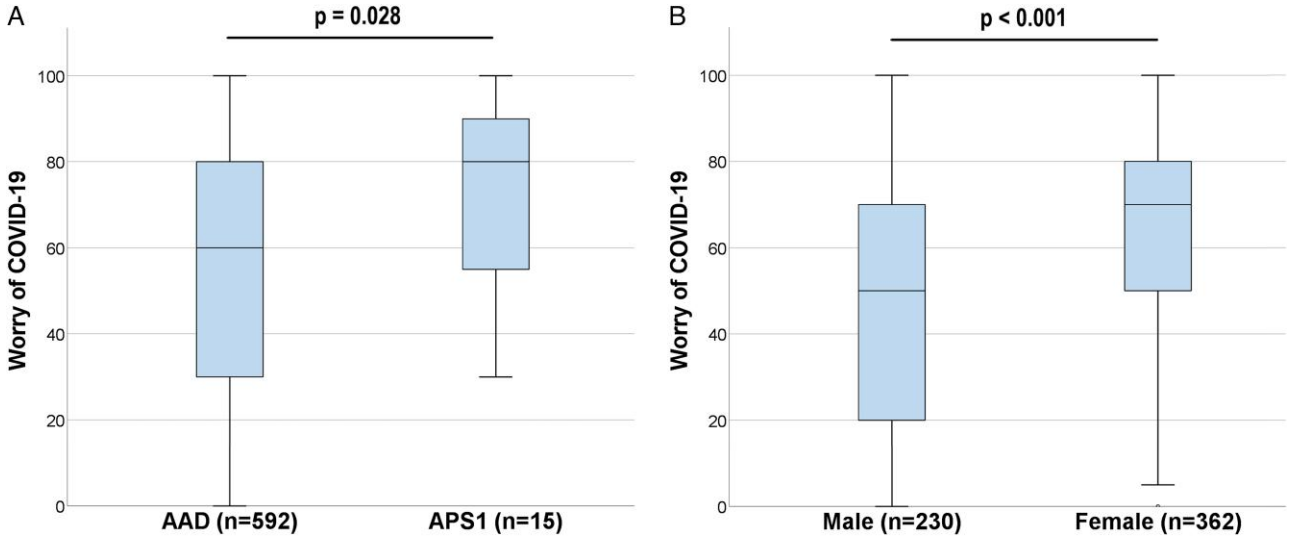

Figure 3. Reported worry about COVID-19 on a scale from 0 to 100. A, Worry about COVID-19 grouped by AAD and APS1 ($P = .028$). B, Worry about COVID-19 in the AAD-group grouped by sex ($P < .001$).

Table 3. Medications and comorbidities in the AAD-group with SARS-CoV-2 infection requiring and not requiring hospital care.

Characteristics	Hospitalization + ($n = 8$)	Hospitalization − ($n = 96$)	*P*-value
Women, *n* (%)	4 (50.0)	63 (65.6)	.451
Age, median (range)	68 (38-81)	52 (22-87)	.002
Comorbidities, *n* (%)			
Hypothyroidism	6 (75.0)	38 (39.6)	.073
Diabetes mellitus type 1	2 (25.0)	12 (12.5)	.293
Diabetes mellitus type 2	2 (25.0)	3 (3.1)	.047
Hypertension	3 (37.5)	5 (5.2)	.014
Previous acute coronary syndrome	2 (25.0)	0 (0.0)	.005
Previous stroke	0 (0.0)	2 (2.1)	1.000
Asthma	0 (0.0)	1 (1.0)	1.000
Chronic obstructive pulmonary disease	0 (0.0)	0 (0.0)	NA
Medications, *n* (%)			
Hydrocortisone	7(87.5)	79 (82.3)	1.000
Modified release hydrocortisone	1 (12.5)	15 (15.6)	1.000
Other glucocorticoid treatment[a]	0 (0.0)	2 (2.1)	1.000
Fludrocortisone	5 (62.5)	90 (93.8)	.021
Levothyroxine	6 (75.0)	49 (51.0)	.276
Anti-hypertensive drugs	4 (50.0)	5 (5.2)	.002
Lipid-lowering drugs	5 (62.5)	11 (11.5)	.002
Medications against infections[b]	1 (12.5)	17 (17.7)	1.000
Other medications	5 (62.5)	55 (57.3)	1.000

Includes cases not confirmed with PCR or antibody screening.
[a]Cortisone acetate, hydrocortisone pump, or prednisolone.
[b]Viral, bacterial and/or fungal infections during the past year.
Abbreviation: NA, not applicable.

Discussion

This large national cohort study focuses on patients with AAD enduring and surviving the COVID-19 pandemic predominantly during the pre-vaccine phase in Sweden. We observed that although a large proportion of the patients with AAD were infected with SARS-CoV-2 few required hospital care. Younger age and less worry about infection were associated with a higher risk of infection and a majority of patients increased their glucocorticoid dose during the SARS-CoV-2 infection. Older age and cardiovascular risk factors were associated with a higher risk of hospitalization for COVID-19 and management of glucocorticoid medications during hospitalization was heterogeneous. Few of the participants reported receiving satisfactory information by healthcare on how to handle COVID-19 with regard to their AAD and few received the temporary subsidy offered to risk groups.

In this cohort, 17% of the participants reported contracting COVID-19. Parameters associated with a higher risk of SARS-CoV-2 infection were younger age and less worry about infection. Since 98 of the 106 reported cases occurred before the start of national vaccinations of individuals with AAD, vaccinations likely had minor effect on the results of this study. However, it cannot be ruled out that more cases and hospitalizations could have been reported if vaccinations had started at a later date. The lower incidence of hypertension and usage of anti-hypertensive drugs in the infected group is most probably a confounding factor since hypertension is more common with older age. People who had experienced an adrenal crisis during the past 5 years did not have an increased risk of infection or hospitalization because of COVID-19. No association between glucocorticoid dosage and risk of infection or hospitalization was found which is in line with the results of Smans et al.[12] Our results did show that men had higher total daily glucocorticoid doses than women. However, this was not adjusted for body weight, and we did not find any significant sex differences regarding risk of infection or hospitalization. Hence, none of the specific characteristics of AAD, such as maintenance glucocorticoid dosage or previous adrenal crises, was found to be risk factors for infection with SARS-CoV-2 or hospitalization because of COVID-19.

A majority of patients increased their glucocorticoid dosage upon contracting COVID-19. This could be interpreted as a result of patient education provided to individuals with AAD. Among those sick for 3 days or less, the most common approach was to not increase the glucocorticoid dosage. It can be assumed that a shorter duration of sickness is an indication of a mild infection, and it is therefore possible that the patients did not deem it necessary to increase their glucocorticoid dosages while sick. Our results show that those who had managed to avoid COVID-19 reported being more worried of infection than those who had been sick with COVID-19 which could be a consequence of worried individuals isolating themselves and thereby avoiding infection or it could be interpreted as that when an individual had experienced the infection there was no longer a reason to worry. Furthermore, women were more worried than men which is in line with the results reported by Li et al.[14] A clear majority of participants reported not receiving any information from healthcare regarding adrenal insufficiency and COVID-19 and few reported receiving the temporary subsidy offered to risk groups in Sweden. Although a high number of participants increased their glucocorticoid dosage during illness and no increase in the number of adrenal crises in comparison to previous years could be seen based on the self-reported data, the results of this study highlight the need of increased communication from healthcare to individuals with AAD in case of a pandemic.

Hospital care was required by 8.5% of those who got infected with SARS-CoV-2. Old age, hypertension, anti-hypertensive drugs, and no treatment with fludrocortisone were associated with increased risk of hospitalization. Fludrocortisone being less common among those who had required hospital care is likely due to that hypertension is a common reason for fludrocortisone to be discontinued especially considering that the difference did not remain significant after exclusion of subjects with anti-hypertensive drugs. However, the group of patients who were hospitalized was too small to draw certain conclusions. Moreover, the higher frequency of lipid-lowering drugs in the hospitalization group is likely a result of confounding factors considering that lipid-lowering drugs are more common with old age. Hypertension and old age have been associated with an increased risk of severe COVID-19 in several previous studies, supporting our results.[9]

Almost all patients requiring hospital care were given intravenous hydrocortisone and fluids upon admission which is in line with the guidance provided in the *European Journal of Endocrinology*.[20] A majority of patients were hospitalized for 3 days or less with no indication of an ongoing adrenal crisis and minor needs of supplied oxygen because of COVID-19. In other words, individuals with AAD seem to have been admitted despite being relatively stable to assure that the patient did not develop severe COVID-19 or an adrenal crisis. However, despite that this is a large national study, the cases were few and the management of glucocorticoid medications

was heterogeneous, and it is not possible to draw any conclusions regarding which regime, if any, reduces morbidity or duration of hospitalization. There is guidance provided in the *European Journal of Endocrinology*,[20] but it was not adhered to in the cases observed in this study.

Finally, we found that patients with APS1 reported receiving information from healthcare to a greater extent than the AAD-group. APS1 was also associated with a higher degree of worry about infection. The group of patients with APS1 with a reported SARS-CoV-2 infection was too small to draw any conclusions regarding risk factors for infection or hospitalization and they were therefore excluded from all analyses regarding risk factors. However, it is notable that the only person with APS1 that required hospital care also required intensive care. More research is needed to investigate whether adrenal insufficiency plays any role in the association between APS1 and severe COVID-19.

The primary strength of this study was the large number of participants in different age groups from all over Sweden. Furthermore, the strict inclusion criteria specified that only AAD and APS1 were to be included to ensure a homogeneous cohort of autoimmune PAI. Previous studies from Norway and Italy found similar results regarding the prevalence of 21-OH-autoantibodies, hypothyroidism and DM1 in patients with AAD[21,22] and hence, it can be assumed that the cohort used in this study is representative for AAD as a group. It is, however, difficult with a survey study like this to determine whether AAD is a risk factor for severe COVID-19. We did not include a control group and the ethical permission did not allow us to search medical records of patients without signed informed consent. Thus, this study most likely underestimates the risk of hospitalization and death. Other limitations of our study are lack of data regarding body mass index and ethnicity, and lack of questions regarding the time-period after the acute COVID-19 infection, such as long COVID and quality of life after the infection. We used a self-reporting approach and consequently the risk of recall bias must be considered for the presence of symptoms and events such as an eventual adrenal crisis. Yet, this study design allows for unique insight into the self-management of AAD.

Conclusion

In the largest study to date examining AAD during the COVID-19 pandemic, we observed that although a large number of patients contracted COVID-19 few of them required hospital care. This study gives a unique insight of the self-management in a patient group where patient education is of outmost importance. A majority of the patients increased their glucocorticoid medications upon contracting COVID-19, yet the results of this study highlight the necessity of communication between healthcare and patients during pandemics. In the future, it would be interesting to investigate the incidence of long COVID and mortality in this patient group.

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Supplementary material

Supplementary material is available at *European Journal of Endoicrinology* online.

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Conflict of interest: O.K. is a board member of Navinci Diagnostics AB. D.E. has received lecture fees from Ipsen and Pfizer.

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