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Impact of the COVID-19 Pandemic on Psychosocial Distress in Adolescents with Obesity Compared to Those with Type 1 Diabetes: Results from the KICK-COVID Study in Germany

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Keywords
Chronic health condition · Obesity · Type 1 diabetes · Adolescents · COVID-19 · Psychosocial distress

Abstract
Introduction: The aim of this study was to investigate the impact of the COVID-19 pandemic on psychosocial well-being in adolescents with obesity compared to those with type 1 diabetes. ***Methods:*** As part of the German KICK-COVID Study, adolescents aged 12–21 with overweight or obesity from the German/Austrian Adiposity Follow-up Registry (APV) completed well-being, anxiety, and depression questionnaires (WHO-5, GAD-7, PHQ-9) during routine visits amidst the COVID-19 pandemic. By multivariable linear regression models, adjusted for age, gender, and immigration background, the association between psychosocial distress, anthropometrics, and cardiometabolic risk factors was analyzed. Data were compared to those of youth with type 1 diabetes from the German/

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Austrian Diabetes Follow-up Registry (DPV) and normative values from the general population. Additionally, a mediation analysis examined the impact of loneliness on mental health through media consumption. ***Results:*** From June 2021 to September 2023, 235 adolescents from 6 German and 1 Austrian pediatric obesity centers were enrolled. Results were compared to 235 age- and gender-matched participants from the DPV registry (54.04% males; mean age 15.21 ± 1.66 years) and normative values. Youth with type 1 diabetes were more anxious about their health risk, but distress factors were more pronounced in the APV group ($p < 0.001$). Girls from the APV group showed higher mental distress than boys across all applied questionnaires, but not for age, BMI-SDS, and migration background as predictors. Perception of loneliness correlated with poorer mental health outcomes, but it was not associated to media consumption. Comparisons with normative values revealed significantly higher depression and anxiety scores ($p < 0.001$) and lower well-being scores in the APV group ($p < 0.01$). ***Conclusions:*** Youth with obesity and diabetes experienced significant psychosocial distress during the COVID-19 pandemic. Disease-specific differences were observed on the level of single items: Adolescents with type 1 diabetes expressed heightened concern about their health risks, while those with obesity reported lower self-esteem, increased suicidal thoughts, and fluctuating appetite. Female gender appeared to pose an additional risk factor. Media consumption was notably higher in the APV cohort. Healthcare providers should be vigilant regarding psychological comorbidities in youth with chronic conditions, particularly during periods of heightened stress.

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Introduction

Restrictions due to the coronavirus diseases (COVID-19) pandemic disrupted daily routines and limited interactions with friends and peer groups [1, 2]. Psychosocial burden was especially high in children and adolescents compared to adults, and an increase in anxiety, depression, and other mental health problems was observed [3, 4]. Childhood and adolescence are critical periods not only for physical but also for cognitive, social, and emotional development, representing vulnerable phases for mental health [5]. Increased media consumption and altered sleep behavior during the COVID-19 related lockdowns may also have had negative impact on physical and mental health of children and adolescents [6]. Preexisting chronic disease and mental health problems may additionally have fostered the development of symptoms of anxiety and depression during the COVID-19 pandemic [7], although access to healthcare was largely preserved for children and adolescents with a chronic health condition, including children with type 1 diabetes, rheumatic disease, and obesity [8]. Little is known about the influence of the COVID-19 pandemic on psychosocial well-being and mental health in adolescents with chronic disease so far. Depending on the underlying disease, different effects were to be expected. For children and adolescents with type 1 diabetes, the fear of infection and the effects on the diabetic metabolic state were in the forefront. For children and adolescents with obesity, homeschooling with more sitting time, less exercise, and in some cases, increased snacking were reasons for weight gain. Subsequently, psychological problems in particular were described for type 1 diabetes [9] and the effects of being bored and inactive for obesity [10]. However, to the best of our knowledge, there is no study to date that has explored these chronic diseases in childhood and adolescence in parallel using standardized methodology.

The aim of this study was to evaluate the impact of the pandemic on symptoms of anxiety, depression, and stress in adolescents with obesity and type 1 diabetes [11, 12] and to compare results to normative values for the general population (pre-pandemic and during the COVID-19 pandemic). In addition, the influence of age, sex, and immigration background, as well as the association between psychosocial distress, anthropometrics, and cardiometabolic risk factors in both groups with chronic diseases (APV and DPV) was investigated.

Methods

This study was part of the KICK-COVID study, a prospective analysis of the long-term impact of the COVID-19 pandemic on well-being and healthcare among children with a high-risk chronic condition and their families [1]. This observational study from Germany aimed to examine the effect of the COVID-19 pandemic on clinical parameters and psychosocial well-being of children with chronic health conditions and their families [1, 8, 12]. Data were obtained between June 2021 and September 2023. Recruitment and data collection was performed within German and Austrian centers treating children and adolescents with obesity and reporting data to the German/Austrian Adiposity Follow-up Registry (APV).

Data were compared to those of adolescents with type 1 diabetes from the German/Austrian Diabetes Follow-up Registry (DPV). Both groups were propensity score-matched for age and gender, where standardized differences <10% were considered negligible. Caliper width was set to 0.2 [13]. In addition, data of mental distress of

both groups were compared to normative values from the general population (pre-pandemic data and data during the COVID-19 pandemic).

The KICK-COVID study was designed according to the principles of the revised Declaration of Helsinki, and the study protocol was approved by the Ethics Committee of the University of Potsdam (request number 62/2020). All participants and legal guardians gave written informed consent prior to the study and use of datasets for research purposes. The study was conducted following the Declaration of Helsinki as well as the EU General Data Protection Regulation (GDPR). The entire study followed the STROBE reporting guideline for cohort studies.

Study Questionnaires

As previously described, perceived risk due to COVID-19 was measured with two self-constructed items [1, 11, 12]: adolescents indicated how dangerous they consider a SARS-CoV-2 infection to be for themselves on an 11-point Likert scale as well as indicated their perceived risk of SARS-CoV-2 infection on a scale ranging from 0 (totally unlikely) to 10 (very likely).

Additional items included daily hours of media consumption (computer/internet, TV, video games on console, smartphone). Loneliness was assessed with a single item using an 11-point NRS (0 = not lonely at all to 10 = totally lonely).

Well-Being

General well-being of participants during the past 2 weeks before the clinical visit was assessed by the German version of the World Health Organization Five Well-Being Index (WHO-5), as previously described [14]. The questionnaire is based on a 5-item Likert scale ranging from 0 (at no time) to 5 (all of the time). Raw scores ranging from 0–25 were transformed to a score from 0 (lowest well-being) to 100 (highest well-being) [14]. The WHO-5 has been validated in a large sample of adolescents and adults (14–99 years) in Germany, and reliability was confirmed [15]. Besides, it is validated for use in adolescents with type 1 diabetes [16] and widely administered in the field of other chronic health conditions [17]. Whereas Lambert et al. [18] and McMahon et al. [19] have generated normative values in large representative cohorts before the COVID-19 pandemic, Dale et al. [20] have applied the WHO-5 in a large sample of high school students from Austria during the pandemic.

Anxiety Symptoms

The German version of the General Anxiety Disorder-Scale (GAD-7) was used to measure anxiety symptoms during the past 2 weeks [18–20], applying a 4-point Likert scale which consists of seven items (range: from 0 (not at all) to 3 (nearly every day)). Validity and reliability of the GAD-7 were confirmed in a large German sample before the pandemic, and normative data were generated in a large German and Finnish sample before the pandemic [21, 22]. A sample of Austrian high school students provided comparative values during the pandemic [20]. Higher scores represent higher anxiety levels.

Depressive Symptoms

The German version of Patient Health Questionnaire (PHQ-9) was applied to measure depressive symptoms during the past 2 weeks [23], using a 4-point Likert scale from 0 (not at all) to 3 (nearly every day). A maximum score of 27 could be indicated, with higher scores representing more depressive symptoms. Validity and reliability were confirmed [23]. Normative data for the PHQ-9 are available for several age groups, including adolescents aged 14–24 years [23], as well as comparative values from Austrian high school students during the pandemic [20]. Albeit not explicitly validated in this group, the GAD-7 and PHQ-9 are common instruments to measure anxiety and depression in adolescents with chronic health conditions such as obesity and type 1 diabetes [24–26].

Media Consumption

Types of screen-based media use were assessed using a questionnaire, which asked for the overall amount of daily time spent with different screen media (television/videos, computer/internet, smartphone, and gaming consoles). According to a large population-based representative study [27], an index for screen time was formed: for television/videos, computer/internet, and gaming consoles, individual answers were scored with 0 (not at all), 0.5 ("about half an hour"), 1.5 ("about 1–2 h"), 3.5 ("about 3–4 h"), and 5 ("more than 4 h") and summed up across these media [27].

APV Registry

For this study, pooled data (status 12/2023) from the standardized multicenter APV registry were analyzed (www.a-p-v.de) [28]. The registry was developed on behalf of the German Working Group of Obesity in Childhood and Adolescence (www.a-g-a.de) since 1999 and collects longitudinal data on children and adolescents with obesity from Germany, Austria, and Switzerland. In all participating APV centers, a standardized electronic health record is used to document both anthropometric and metabolic parameters of participating children and adolescents. Data are pseudonymized and transferred to Ulm, Germany, twice yearly for central plausibility check:

incomplete or not plausible data are reported back to participating centers for validation and/or correction. Data are integrated into a completely anonymized, cumulative database at Ulm University, Germany [28].

DPV Registry

Similar to the APV data collection (status 12/2023), pooled data from the German Diabetes Follow-up Registry (DPV) was analyzed and served as control cohort to the APV group. The DPV registry comprises 257 pediatric diabetes centers from Germany, Austria, Switzerland, and Luxembourg. As for the APV registry, locally collected longitudinal data are pseudonymized and transmitted for central plausibility checks and analyses to Ulm University twice a year.

The Ethics Committee of Ulm University has approved the analyses of anonymized data from both, the APV and the DPV registry (APV: request number 133/22; DPV: request number 314/21). Data protection and ethical guidelines correspond to local standards and all participating institutions confirm adherence to local data protection regulations. All data generated or analyzed during this study are included in this article. Further inquiries can be directed to the corresponding author.

Anthropometric, Clinical and Demographic Data

Data for analyses were obtained between June 2021 and September 2023. Adolescents aged 12–21 years with overweight (BMI ≥90 percentile) or obesity (BMI ≥97 percentile) were included [29]. In addition, the following parameters were collected:

- Body weight, body length, waist circumference, systolic/diastolic blood pressure.
- Laboratory parameters: fasting glucose, fasting insulin, HOMA-IR, HbA1c, serum uric acid (sUA), ALAT, ASAT, GGT, total cholesterol, HDL-C, LDL-C, triglycerides.

As predictors for regression analyses, the following parameters were included:

- Age and gender of participants.
- Immigrant background (APV: patient or at least one parent born outside of Germany or Austria; DPV: patient or at least one parent born outside of Germany, Austria, Luxembourg, or Switzerland).

Body mass index (BMI) was calculated as weight in kilogram divided by height in meter squared, and BMI values were transformed to standard deviation scores (BMI-SDS) based on German reference values, applying the Box-Cox transformation method [30]. A cutoff ≥1.28 SDS (90th centile) is applied to classify overweight, a cutoff ≥1.88 SDS (97th centile) is applied to classify obesity, and a cutoff ≥2.58 SDS (99.5th centile) is applied to classify extreme obesity [30].

Dyslipidemia was defined as cholesterol ≥200 mg/dL and/or HDL-C ≤35 mg/dL and/or LDL-C ≥130 mg/dL. Arterial hypertension was defined as systolic and/or diastolic blood pressure ≥95 reference percentile according to the German KiGGS study [30]. Disturbed glucose metabolism was defined as fasting blood glucose >100 mg/dL and/or 120 min blood glucose in oral glucose tolerance testing ≥140 mg/dL and/or HbA1c ≥5.7%.

Statistical Analysis

Descriptive analyses for the APV cohort are presented as median with interquartile range or percentages. For outcomes related to psychosocial distress and mental health (GAD-7, PHQ-9, WHO-5) within the APV cohort, we performed linear regression analyses with age, gender, migration background, and BMI-SDS as predictors. Normality was checked by visual inspection of quantile-quantile plots. Complete case analysis was conducted, and no imputation of missing data was performed. Results are presented as beta coefficients with 95% confidence intervals (CIs). In addition, least squares means together with 95% CI are shown in visual presentation of the regression results. Two-sided p values <0.05 were considered statistically significant.

To examine the indirect effect of loneliness on well-being (WHO-5), anxiety (GAD-7), and depression (PHQ-9) through media consumption (screen time), we tested three single-mediator models. In terms of media consumption, a sum score included the four items referring to a medium with screen (computer/internet, TV/video, smartphone, gaming console). We statistically controlled for age, gender, and immigrant background. Unstandardized effects are reported along with Wald 95% CIs and p values.

For the comparison of PHQ-9 and GAD-7 scores between the APV cohort and normative values for the general population, as published by Löwe et al. [22] and Kocalevent et al. [23], a two-sample t test was applied. WHO-5 scores were compared to a representative sample of adolescents (WHO-5 scores: raw values were considered [22]. In a second step, we compared PHQ-9, GAD-7, and WHO-5 scores with scores from a large sample of high school students from Austria during the COVID-19 pandemic [20].

Unadjusted comparisons between APV und DPV cohorts were performed using Wilcoxon's rank sum test for continuous and chi-square tests for dichotomous outcomes. Two-sided p values were adjusted for multiple testing via Bonferroni stepdown method. For the comparison of the APV and DPV cohorts, we performed propensity score matching with a greedy 1:1 algorithm

using age and gender, with a caliper width of 0.2. Standardized differences of <10% were considered negligible. In terms of effect sizes, Cohen's *d* was calculated (small effect: $d = 0.20–0.49$, medium effect: $d = 0.50–0.79$, large effect: $d \geq 0.80$) [31] for continuous variables, and Cramer's V was calculated (small effect: V = 0.10, medium effect: V = 0.30, large effect: V = 0.50) [32] for dichotomous variables.

To test the hypothesis that the effect of loneliness on psychosocial distress (namely, anxiety, depression, and lower well-being) might be mediated by media consumption, we performed mediation analyses in both cohorts. Analyses were performed with SAS version 9.4 (SAS Institute Inc., Cary, NC, USA). *p* values <0.05 were considered statistically significant.

Results

Study Cohorts

A total of 235 adolescents with overweight or obesity from 6 German and 1 Austrian pediatric obesity centers as well as a total of 235 age- and gender-matched adolescents with type 1 diabetes participated in this study (54.04% males; mean age 15.21 ± 1.66 years). Immigration background for the APV group was documented for 44% of the participants. As expected, BMI-SDS was significantly different between both cohorts (APV: 2.34 ± 0.41; DPV: 0.35 ± 0.92; $p < 0.001$). Baseline characteristics of both cohorts are presented in Table 1.

Clinical Characteristics of the APV Cohort

Out of the 235 participants with overweight or obesity, 180 (37.8%) showed one or more abnormal lipid parameters, 223 (44.4%) had arterial hypertension, and 118 (31.4%) had disturbed glucose metabolism.

Linear Regression Analyses for Associations with Psychosocial Distress within the APV Cohort

The linear regression model showed a significant positive association only between female gender and the GAD-7 ($p = 0.01$), PHQ-9 ($p = 0.003$), and WHO-5 ($p = 0.03$) scores, as well as additionally a positive trend between age and PHQ-9 ($p = 0.08$). Girls in the APV cohort had significantly higher total scores with medium effect size for PHQ-9 and as a trend for GAD-7 (but not for WHO-5) than boys, representing more depressive symptoms and more anxiety in girls with overweight/obesity compared to boys (GAD-7: 6.00 [3.00; 10.00] vs. 4.00 [1.00; 7.00], $p = 0.07$; PHQ-9: 8.00 [3.00; 12.00] vs. 4.00 [2.00; 8.00], $p < 0.01$, $d = 0.52$) (Fig. 1a–c).

Mediation Analyses

To test the hypothesis that the effect of loneliness on psychosocial distress (namely, anxiety, depression, and lower well-being) might be associated with media consumption, we performed mediation analyses. Results revealed significant total effects for the three models, respectively (WHO-5: β = 0.74, 95% CI: −1.03 to −0.44, $p < 0.0001$; PHQ-9: β = 0.96, 95% CI: 0.70–1.22, $p < 0.0001$; GAD-7: β = 0.78, 95% CI: 0.57–0.99, $p < 0.0001$). While each direct effect from loneliness on the psychosocial distress variables was significant (WHO-5: β = −0.73, 95% CI: −1.03 to −0.44, $p < 0.001$; PHQ-9: β = 0.95, 95% CI: 0.69–1.21, $p < 0.0001$; GAD-7: β = 0.77, 95% CI: 0.56–0.98, $p < 0.0001$), the effect was not mediated via media consumption (WHO-5: β = −0.002, 95% CI: −0.02 to 0.02, $p = 0.84$; PHQ-9: β = 0.01, 95% CI: −0.03–0.05, $p = 0.61$; GAD-7: β = 0.01, 95% CI: −0.02–0.04, $p = 0.49$). Thus, the hypothesis could not be approved in our study cohort.

Comparisons of Perceived Individual Psychological Distress between the APV Cohort and Normative/Representative Values

Comparisons of the PHQ-9 and the GAD-7 with normative values from the general population [22] and the WHO-5 with a representative sample of adolescents [20] revealed significantly higher scores of depression and anxiety (PHQ-9: APV: 6.83 ± 5.75 vs. norm: 2.3 ± 3.3, $p < 0.001$, $d = 1.11$; GAD-7: APV: 5.54 ± 4.62 vs. norm: 2.76 ± 3.49, $d = 0.73$) and significantly lower scores of well-being (WHO-5: APV: 13.35 ± 5.85 vs. norm: 16.50 ± 5.85) in our APV sample, each with a large effect. However, compared to children from the general population during the COVID-19 pandemic [18, 19], our cohort reported significantly less depression and anxiety (PHQ-9: APV: 6.83 ± 5.75 vs. comp: 12.5 ± 6.62, $p < 0.001$, $d = -0.87$; GAD-7: APV: 5.54 ± 4.62 vs. comp: 10.10 ± 5.37, $p < 0.001$, $d = -0.87$) and significant higher well-being (WHO-5: APV: 53.40 ± 23.40 vs. comp: 36.5 ± 21.2, $p < 0.001$, $d = 0.79$), each with a large effect size.

Comparison of Perceived Health Risk between the APV and DPV Cohorts

Adolescents with type 1 diabetes (DPV cohort) were more concerned about their individual health risk during the COVID-19 pandemic than adolescents with overweight or obesity (APV cohort) ("Fear of getting infected": DPV: 3.92 ± 2.37 vs. APV: 3.23 ± 2.70; $p = 0.03$; $d = 0.27$. "Perceived individual health risk": DPV: 4.92 ± 2.40 vs. APV: 4.05 ± 2.65; $p = 0.007$; $d = 0.34$) (for all items: Likert scale from 1–10 as described above).

Table 1. Characteristics of the APV- and the DPV-cohorts: comparison between demographic characteristics and psychological scores between both study groups

Characteristics	APV (obesity)						DPV (type 1 diabetes)						*p* value, APV vs. DPV
	N	mean	SD	median	Q1	Q3	*N*	mean	SD	median	Q1	Q3	
Age, years	235	15.2	1.7	15.2	14.0	16.5	235	15.2	1.7	15.2	14.0	16.6	1.000
Males (5)		54						54					1.000
BMI-SDS	235	2.3	0.4	2.4	2.0	2.7	231	0.4	0.9	0.4	−0.3	0.9	0.000
HbA1c, %	107	5.4	0.5	5.3	5.1	5.5	221	7.5	1.3	7.3	6.7	8.0	0.000
WHO-5 question 1 (0–5+)	222	3.1	1.4	4.0	2.0	4.0	220	3.4	1.1	4.0	3.0	4.0	0.718
WHO-5 question 2 (0–5+)	222	2.9	1.5	3.0	1.0	4.0	219	2.9	1.3	3.0	2.0	4.0	1.000
WHO-5 question 3 (0–5+)	218	2.5	1.5	2.5	1.0	4.0	217	2.7	1.4	3.0	1.0	4.0	1.000
WHO-5 question 4 (0–5+)	223	2.2	1.8	2.0	1.0	4.0	219	2.1	1.5	2.0	1.0	3.0	1.000
WHO-5 question 5 (0–5+)	221	2.7	1.5	3.0	1.0	4.0	219	2.8	1.3	3.0	2.0	4.0	1.000
WHO-5 sum score	215	13.4	5.9	13.0	9.0	18.0	215	13.9	5.1	14.0	10.0	18.0	1.000
GAD-7 question 1 (0–3–)	219	0.8	0.8	1.0	0.0	1.0	222	0.8	0.9	1.0	0.0	1.0	1.000
GAD-7 question 2 (0–3–)	217	0.7	0.9	0.0	0.0	1.0	222	0.6	0.8	0.0	0.0	1.0	1.000
GAD-7 question 3 (0–3–)	216	0.8	0.9	1.0	0.0	1.0	221	0.8	0.8	1.0	0.0	1.0	1.000
GAD-7 question 4 (0–3–)	217	0.8	0.9	1.0	0.0	1.0	221	0.7	0.8	1.0	0.0	1.0	1.000
GAD-7 question 5 (0–3–)	217	0.6	0.9	0.0	0.0	1.0	223	0.5	0.9	0.0	0.0	1.0	1.000
GAD-7 question 6 (0–3–)	217	1.1	0.9	1.0	0.0	2.0	222	1.1	0.8	1.0	0.0	2.0	1.000
GAD-7 question 7 (0–3–)	215	0.6	0.8	0.0	0.0	1.0	221	0.5	0.8	0.0	0.0	1.0	0.793
GAD-7 sum score	213	5.5	4.6	5.0	2.0	8.0	216	5.1	4.1	4.0	2.0	7.0	1.000
PHQ-9 question 1 (0–3–)	214	0.7	0.8	0.0	0.0	1.0	223	0.6	0.7	0.0	0.0	1.0	1.000
PHQ-9 question 2 (0–3–)	210	0.6	0.8	0.0	0.0	1.0	223	0.4	0.6	0.0	0.0	1.0	0.199
PHQ-9 question 3 (0–3–)	213	1.1	1.1	1.0	0.0	2.0	224	0.8	0.9	1.0	0.0	1.0	0.362
PHQ-9 question 4 (0–3–)	214	1.1	1.0	1.0	0.0	2.0	223	1.1	0.9	1.0	0.0	1.0	1.000
PHQ-9 question 5 (0–3–)	**213**	**1.2**	**1.0**	**1.0**	**0.0**	**2.0**	**222**	**0.7**	**1.0**	**0.0**	**0.0**	**1.0**	**0.000**
PHQ-9 question 6 (0–3–)	**212**	**0.8**	**1.0**	**0.0**	**0.0**	**1.0**	**224**	**0.5**	**0.8**	**0.0**	**0.0**	**1.0**	**0.006**
PHQ-9 question 7 (0–3–)	215	0.7	0.9	0.0	0.0	1.0	224	0.7	0.8	0.0	0.0	1.0	1.000
PHQ-9 question 8 (0–3–)	214	0.5	0.8	0.0	0.0	1.0	222	0.3	0.6	0.0	0.0	0.0	0.959
PHQ-9 question 9 (0–3–)	**214**	**0.3**	**0.6**	**0.0**	**0.0**	**0.0**	**217**	**0.1**	**0.4**	**0.0**	**0.0**	**0.0**	**0.005**
PHQ-9 sum score	199	6.8	5.8	6.0	2.0	11.0	212	5.0	4.4	4.0	2.0	7.0	0.082

Comparison of Perceived Individual Psychosocial Distress between the APV and DPV Cohorts

The general mental well-being (WHO-5), symptoms of anxiety (GAD-7), and depression (PHQ-9) of the participants are shown in Table 1. In total, no significant differences were seen in the PHQ-9 score between both cohorts with a chronic health condition (6.83 ± 5.75 vs. 5.00 ± 4.40; Table 1). To get a deeper understanding on possible differences on the level of symptoms for depression, we decided to look at the single items as well. Controlling for multiple testing, participants from the APV group reported significantly higher scores with small to medium effects for single items related to increased or decreased appetite (for instance, PHQ-9/question 5: APV: 1.15 ± 0.98 vs. DPV: 0.71 ± 0.95; $p < 0.001$; $d = 0.45$), reduced self-esteem (PHQ-9/question 6: APV: 0.79 ± 0.98 vs. DPV: 0.46 ± 0.78; $p < 0.01$; $d = 0.36$), and of note, thoughts related to suicidality (PHQ-9/

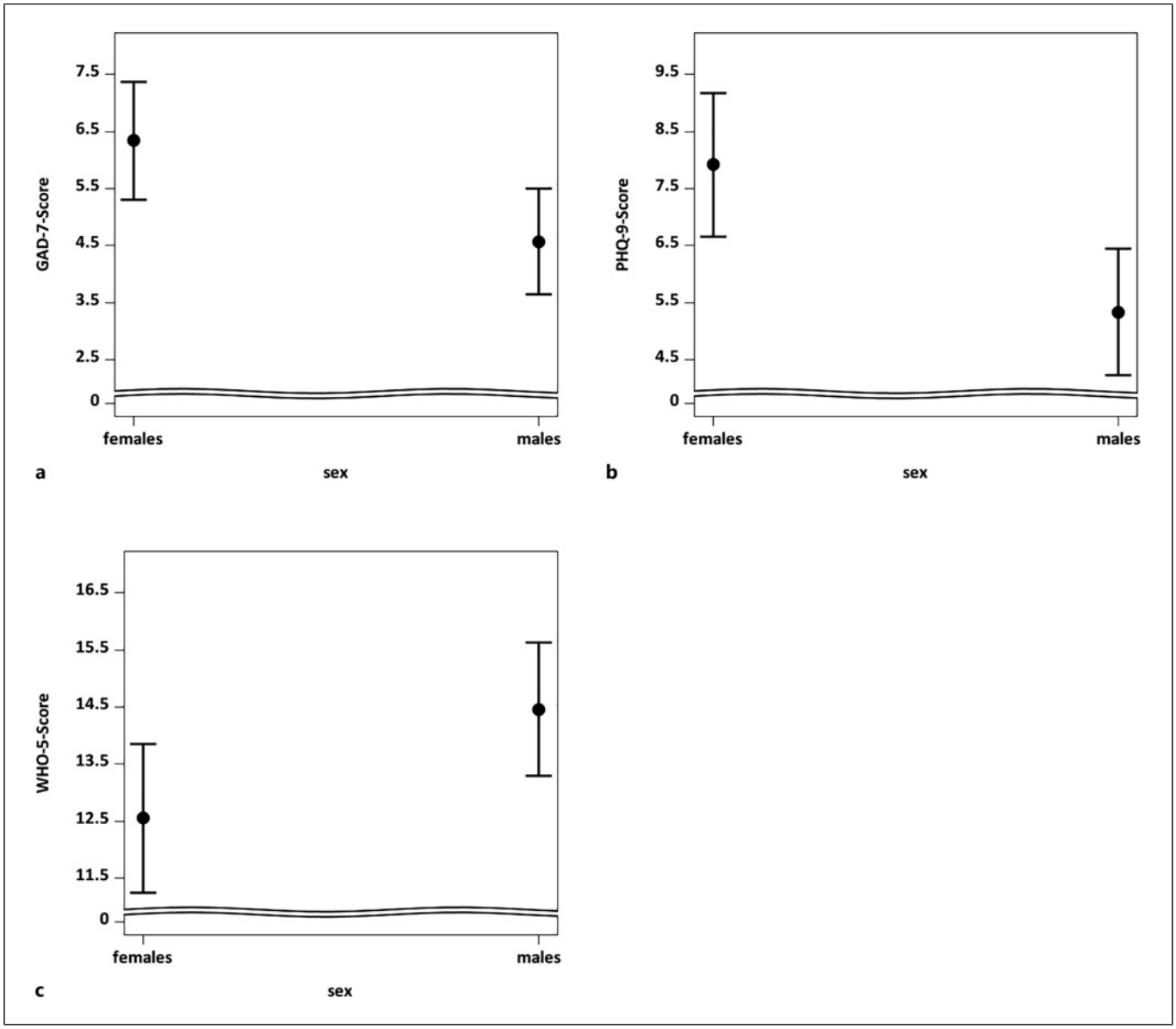


Fig. 1. Adjusted mean scores in the APV cohort by sex together with 95% confidence intervals from linear regression models for GAD-7 (p = 0.0125) (**a**), PHQ-9 (p = 0.0028) (**b**), WHO-5 (p = 0.0327) (**c**).

question 9: APV: 0.26 ± 0.62 vs. DPV: 0.08 ± 0.35; p < 0.01; d = 0.34).

With regard to anxiety (GAD-7) and general well-being (WHO-5), no significant differences were observed between both groups neither in the total mean scores nor on the symptom level (Table 1): GAD-7: mean score was 5.54 ± 4.62 in the APV group and 5.10 ± 4.10 in the DPV group (with a maximum possible score of 21 with higher scores presenting higher anxiety, see Methods). For WHO-5, a mean score of 13.40 ± 5.0 was observed in the APV group and of 13.90 ± 5.10 in the DPV group, with a total possible score of 100 and higher scores representing better well-being (Table 1).

Comparison of Media Consumption between the APV and DPV Cohorts

In all categories of media consumption with screen use, the obesity cohort had a significantly higher usage time than the type 1 diabetes cohort (smartphone p = 0.002, V = −0.13; TV/video p = 0.005, V = −0.10; computer/

internet $p = 0.002$, V = −0.09; video games $p = 0.008$, V = −0.10; chi-square test). In contrast, the difference for the category of listening to music was not significant ($p = 0.1$).

With regard to excessive media use, the proportion of participants who indicated to have a media consumption of > 4 h/day was higher in the APV compared to the DPV group for all media used (smartphone 37.2% vs. 23.8% [$p < 0.001$]; TV/video 10.5% vs. 5.0% [$p = 0.003$]; computer/internet 22.2% vs. 14.8% [$p = 0.01$]; video games 10.2 vs. 4.7% [$p = 0.003$] (Fig. 2a–d); listening to music 16.6% vs. 11.7% [$p = 0.06$]). Within the APV cohort, boys had a significantly higher overall score for media consumption than girls (8.59 ± 3.61 vs. 6.54 vs. 2.78; $p < 0.001$).

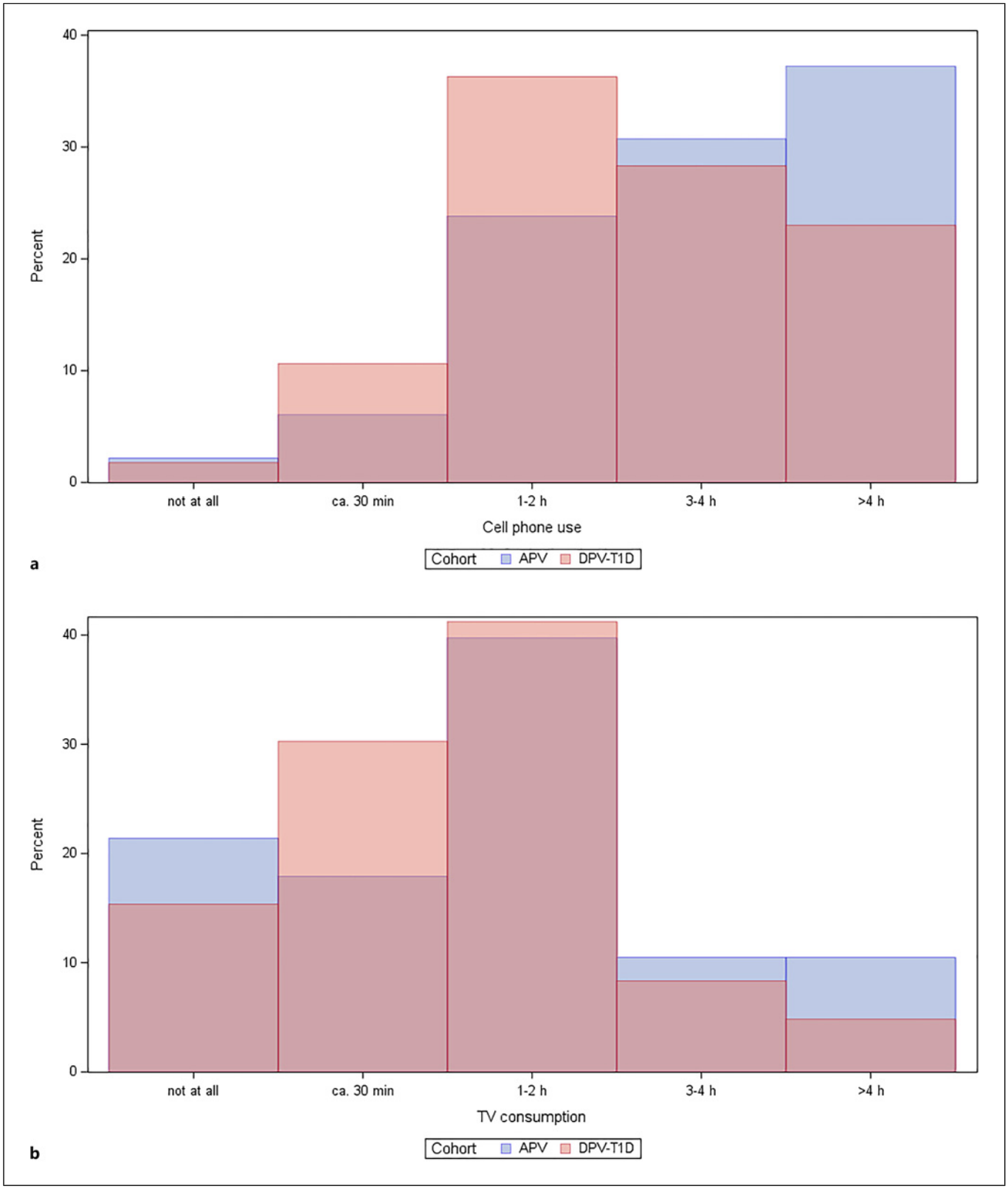
Discussion

The lasting consequences of the COVID-19 pandemic, especially for children and young people, are evident in many areas, such as education, weight and fitness, as well as mental well-being [33]. Children and adolescents with chronic illnesses must be considered separately. The demands of their disease management have exacerbated the pandemic-related obstacles to development. A recent meta-analysis of the impact of the COVID-19 pandemic on children's mental health showed a generally negative impact, regardless of additional chronic conditions [34]. Obesity in adolescents represents a special constellation in this context. Higher scores of depression and anxiety and significantly lower scores of well-being were found in obese children and adolescents (APV cohort) in comparison with children and adolescents without obesity [18–23].

In our cohort of 235 adolescents with obesity available in our study, a relevant proportion is already affected by secondary diseases (dyslipidemia, arterial hypertension, impaired glucose metabolism) [28]. During the COVID-19 pandemic, these young people had an increased risk of a more severe clinical course of COVID-19 infection. Age above 12 years and obesity were two of the main risk factors for the need for intensive care in the pediatric population during the COVID-19 pandemic [35–37]. Nevertheless, the subjects were significantly less concerned about contracting COVID-19 in the self-report and also rated their individual health risk as significantly lower compared to an age- and gender-matched group of adolescents with type 1 diabetes, probably also because adolescents with type 1 diabetes are always continuously concerned about their glucose metabolism, and type 1 diabetes seemed to be an additional risk factor for getting infected with SARS-CoV-2 [38]. Young people with obesity are more prone to originate from families with a lower socioeconomic status [39]. This could potentially explain their reduced level of concern for their own health. On the other hand, a deterioration in the perceived quality of life during the COVID-19 pandemic was shown for this group in particular [40]. In general, adolescents with obesity have an increased risk of behavioral or emotional disorders like depression, eating disorders, and lower self-esteem compared to peers with normal weight. For this reason, additional screening for concomitant mental illnesses is essential in this patient group. There were no significant differences between adolescents with obesity and with type 1 diabetes in their mental well-being during the pandemic. The total scores of WHO-5, GAD-7, and PHQ-9 were not significantly different, but overall were well below or above the normative, representative values from the literature [18, 21, 22]. This result belies the considerable burden on young people with various chronic illnesses during the pandemic.

For all children and young people, the lockdown periods during the COVID-19 pandemic have caused substantial changes in health behavior, including physical activity, media use, and screen time in several countries [41, 42]. Galler et al. [43] reported for a large representative cohort of children and adolescents with obesity from the APV registry that being male was strongly associated with mental health comorbidity. For adolescents with obesity, the positive association of screen time and abdominal obesity was independently shown in a meta-analysis [44]. The comparison between the APV and DPV cohorts showed significantly higher screen time in the APV cohort, regardless of size and type of use (smartphone, TV/video, computer/internet, video games). There was no difference with regard to listening to music. In contrast to previous studies [42–46], we did not find a significant association between media consumption and mental health in terms of depression, anxiety, and well-being. However, other studies have analyzed a longer period of time compared to us. While increased loneliness was associated with deteriorated mental health, this effect was not mediated through screen time.

A markedly increase in obesity prevalence in German children and adolescents during the COVID-19 pandemic has been reported, based on evaluations of the APV registry [47], the Crescent database [48], as well as a parental survey performed by the German Obesity Association [49]. Children with preexisting overweight



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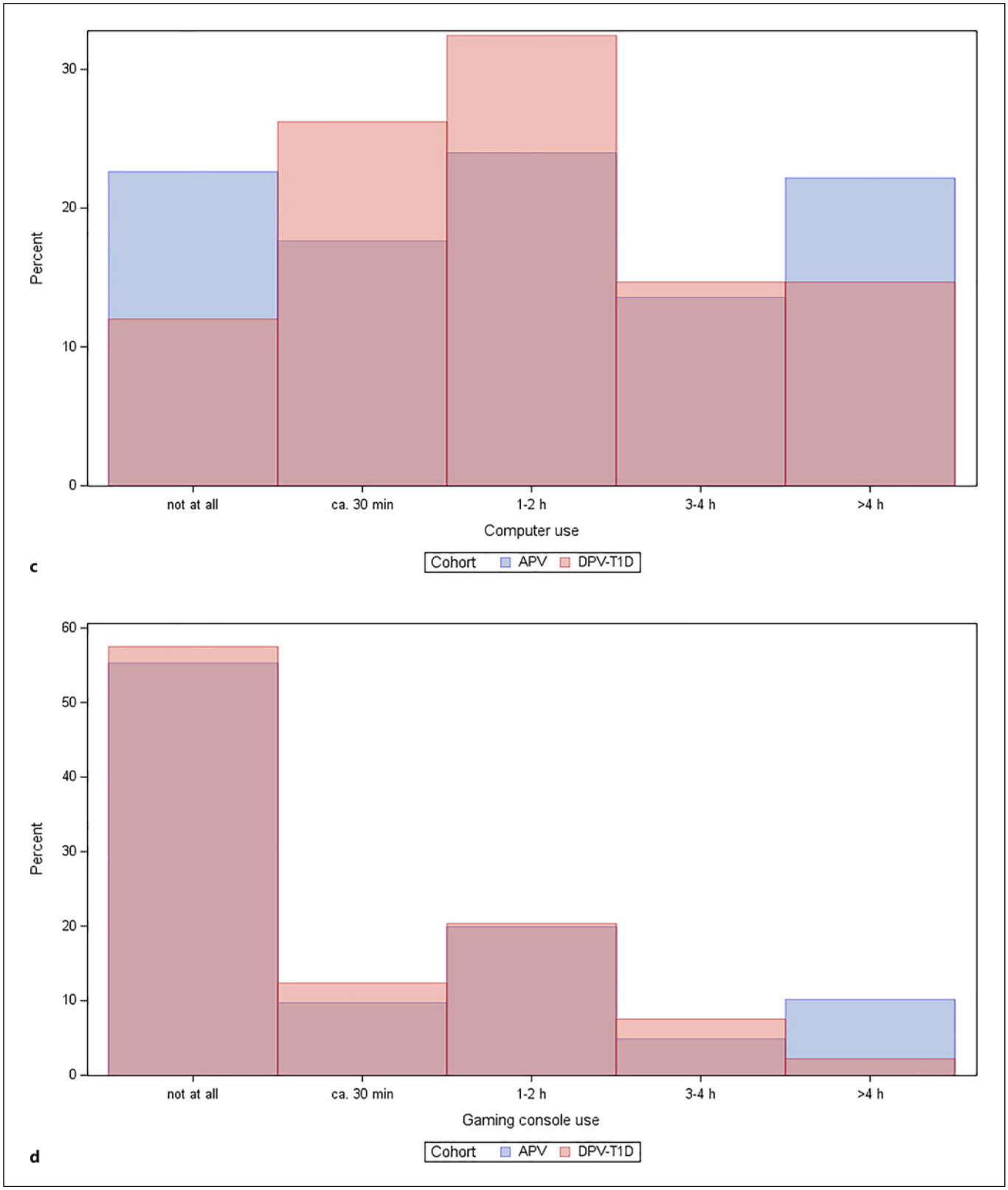

Fig. 2. Comparison of media consumption between the APV and DPV cohorts with regard to excessive media use. The proportion of participants who indicated to have a media consumption of > 4 h/day was higher in the APV compared to the DPV group for all media applied (cellphone (**a**); TV/video (**b**); computer/internet (**c**); video games (**d**)).

or obesity as well as children from families with lower socioeconomic status were more affected, and increased media consumption (beyond increased screen time due to homeschooling) seemed to be an additional risk factor [49]. We now report a significantly higher screen time in the APV cohort compared to the DPV cohort, regardless of type of media use (smartphone, TV/video, computer/internet, video games). This might – at least in part – explain the further increase in obesity prevalence in children and adolescents. The expectation that weight development will normalize after the end of COVID-19 restrictions does not seem to be fulfilled, especially for children with obesity. On the contrary, this group in particular shows further weight gain [50].

In order to better understand factors that might be associated to higher psychosocial burden, we performed a linear and logistic regression model on psychosocial distress and mental health (GAD-7, PHQ-9, WHO-5) with age, gender, migration background, and BMD-SDS as predictors. In line with previous research [51, 52], a positive association on the respective total scores was only shown for female gender (i.e., adolescent girls seem to have increased risk for eating disorders and/or depression).

As the COVID-19 pandemic has been a particular burden for families with chronically ill children, it is important to understand which areas of life are particularly relevant for a return to normality. A review of 10 studies identified the areas of daily routine, physical activity, screen time, and parental stress [53]. Taking these areas of life into account in the care of children and adolescents with type 1 diabetes or obesity can help gradually reduce the consequences of the COVID-19 pandemic.

Strengths and Limitations

The strength of our study is that we have investigated a well characterized cohort of adolescents with two different chronic diseases, namely obesity and type 1 diabetes, which were matched for gender and age, and anthropometric, clinical, metabolic and psychosocial parameters were taken into account. In order to examine their mental situation, well-established instruments were applied. However, there are also some limitations: no comparison was possible with adolescents without chronic disease before and during the pandemic, nor with adolescents with obesity before the pandemic (using the same questionnaires).

Taking into account the prevalence of obesity in adolescents, the group studied was relatively small because only a limited number of APV centers participated in the survey. This is due to the pandemic-related restrictions, which most likely affected smaller facilities to a greater extent than large clinics or outpatient clinics and may have led – at least in part – to a selection bias. For young people with obesity and a migration background, answering questionnaires in general is often a hurdle, as they fear that they may not fully understand the questions.

With regard to regression analyses, we conducted complete case analyses. However, both complete case analyses and imputation might introduce bias, in case individuals with missing information vary from those with available information [54]. Moreover, residual confounding of the results cannot be ruled out due to the fact that other factors might have an impact such as nutrition habits or individuals socioeconomic factors that are difficult to measure in large registries. With regard to mediation analyses, the cross-sectional design might appear as an additional limitation. Longitudinal analyses might be desirable for future research.

Conclusion

Youth with obesity and diabetes were significantly but equally affected by psychosocial distress during the COVID-19 pandemic. Only small disease-related differences emerged on symptom level. Besides the higher concern about their own health risk of youth with type 1 diabetes, youth with obesity reported particularly lower self-esteem and increased suicidality thoughts. For youths with obesity – similar to the general population – female gender seems to be an additional risk factor for reduced well-being as well as for depression and anxiety. Excessive media consumption was significantly higher in youth with obesity compared to type 1 diabetes. Healthcare providers should be aware of this additional potential comorbidity in youth with chronic conditions. Screening instruments for additional mental illnesses should be used regularly, especially for girls from puberty onward. A possible media addiction should always be addressed diagnostically, especially because problematic media consumption is a major cause of increased sitting times, particularly in adolescents with obesity. Family support should be provided, especially for families with chronically ill children.

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KICK-COVID study (a list of the participating centers is provided in the supplement; for all online suppl. material, see https://doi.org/10.1159/000542756).

Statement of Ethics

The KICK-COVID study was designed according to the principles of the revised Declaration of Helsinki, and the study protocol and sampling were approved by the Ethics Committee of the University of Potsdam (request number 62/2020). All participants and legal guardians gave written informed consent prior to the study and use of datasets for research purposes. The KICK-COVID study was conducted following the Declaration of Helsinki as well as the EU General Data Protection Regulation (GDPR). The entire study followed the STROBE reporting guideline for cohort studies. The Ethics Committee of Ulm University has approved the analyses of anonymized data from both the APV and the DPV registry (APV: request number 133/22; DPV: request number 314/21). Data protection and ethical guidelines correspond to local standards, and all participating institutions confirm adherence to local data protection regulations.

Conflict of Interest Statement

The authors have no conflicts of interest to declare related to this manuscript.

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Author Contributions

Concept and design of this study: S.W.-B., S.W., R.W.H., J.G., and P.W. Concept and design of the KICK-COVID study: P.W., J.G., K.M., S.L., C.K., C.S., and R.W.H. Acquisition, analysis, or interpretation of data and critical revision of the manuscript for important intellectual content: S.W.-B., S.W., S.T., S.G.-P., S.L., C.K., K.M., C.L., S.L., A.B., F.R., J.G., and P.W., and R.W.H. Drafting of the manuscript: S.W.-B. and S.W. Statistical analyses: S.T., S.L., and R.W.H.

Data Availability Statement

All data generated or analyzed during this study are included in this article. Due to protection of patient privacy and the specifications in the patient/parent consent form, it is not allowed to share patient level data with researchers outside Ulm University. However, aggregated data are available, and collaboration based on remote data access is possible. Further inquiries or collaboration proposal can be directed to the corresponding author.

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