**COVID-19 and children with congenital anomalies: a European survey of parents’ experiences of healthcare services.**

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# Abstract

## Objective

To survey parents and carers of children with a congenital anomaly (CA) across Europe about their experiences of healthcare services and support during the COVID-19 pandemic.

## Design

Cross-sectional study.

## Setting

Online survey in 10 European countries, open from 8th March 2021 to 14th July 2021.

## Population

1,070 parents and carers of children aged 0-10 years with a cleft lip, spina bifida, congenital heart defect (CHD) requiring surgery, and/or Down syndrome.

## Main outcome measures

Parental views about: the provision of care for their child (cancellation/postponement of appointments, virtual appointments, access to medication), the impact of disruptions to healthcare on their child’s health and well-being, and satisfaction with support from medical sources, organisations and close relationships.

## Results

Disruptions to healthcare appointments were significantly higher (p<0.001) in the UK and Poland, with approximately two-thirds of participants reporting ‘cancelled or postponed’ tests (67/101; 256/389) and procedures compared with approximately 20% in Germany (13/74) and Belgium/Netherlands (11/55). A third of participants in the UK and Poland reported ‘cancelled or postponed’ surgeries (22/72; 98/266) compared with only 8% in Germany (5/64). In Poland, 43% (136/314) of parents reported that changes to their child’s ongoing treatment had moderately to severely affected their child’s health, significantly higher than all other countries (p<0.001). Satisfaction ratings for support from general practitioners were lowest in the UK and Poland, and lowest in Poland and Italy for specialist doctors and nurses.

## Conclusion

A large proportion of participants reported disruptions to healthcare during the pandemic, which for some had a significant impact on their child’s health. Regional differences in disruptions raise questions about the competence of certain healthcare systems to meet the needs of this vulnerable group of patients and indicate improvements should be strived for in some regions.

## Keywords

congenital anomaly, COVID-19, child, parental experience, provision of healthcare, support, survey

# Strengths and limitations

* Surveys the experiences of a large total number of parents and carers across several European countries and congenital anomaly types. The proportion of each CA type in the study sample reflects the relative number of live births with each CA in Europe.
* High item-level response rates, suggests that survey items were relevant to participants and easy to complete.
* Potential bias in responses due to the use of social media for recruitment, for example, excluding people living with ‘digital poverty’ and those who do not engage with patient and parent organisations, limiting the generalisability of findings.
* Inability to conduct a full pilot of the final survey to explore item acceptability, comprehension, and relevance. Possible that there may be some issues with the wording or content of items.

# Background

The coronavirus disease 2019 (COVID-19) pandemic put pressure on healthcare systems worldwide, causing severe disruptions to the delivery of non-essential services, as staff were re-deployed to acute care, and outpatient treatment and follow-up was reduced due to concerns about viral transmission in hospital.1-3 Non-urgent elective care was the most heavily impacted, with a record backlog of 5.6 million cases reported in England in July 2021.4,5

Congenital anomalies (CAs) are a range of conditions that are present from birth and remain a leading cause of childhood morbidity and long-term disability.6,7 Children with CAs require regular clinical follow-up,8 including more frequent primary care appointments, hospital admissions, and surgeries than children without CAs.9-12 Although children are less affected by SARS-CoV-2 infection than adults,13 Down syndrome has been indicated as a risk factor of severe disease and mortality,14,15 and children with underlying conditions may be at increased risk of infection.16 It is crucial to document the healthcare experiences of children with CAs during this period of increased pressure on healthcare systems, especially as they represent a vulnerable population. Existing research, conducted during the first wave of the pandemic in 2020, suggests a high proportion of cancellations and postponements to pediatric healthcare appointments and treatments in the United States17 and in Europe.18-22 Disruptions to the healthcare services of children with CAs were found to cause anxiety for parents,20 and fear that their child’s health may be negatively affected.22 Corcerns about SARS-CoV-2 infection were also common among parents,23,24 which coupled with reductions in other communicable infections during the pandemic,25,26 resulted in fewer visits to clinics25,27 and emergency departments26,28 in 2020. Parents reported a lack of support from healthcare professionals, including the absence of specific COVID-19 related guidance for children.22,29

This paper describes a cross-sectional online survey which explored the views of parents and carers of children with CAs about: (a) their healthcare experiences, and (b) their experiences of support, one year into the pandemic. The survey was conducted as part of a collaborative European project, “Establishing a linked European Cohort of Children with CAs (EUROlinkCAT)”,30 which aims to investigate health and educational outcomes in children born with CAs using population-based data. Due to differences in the level of restrictions, healthcare systems, and the availability of resources between countries, the survey was conducted in several European countries, to explore possible variations in the provision of care.

# Methods

This study is reported following the Strengthening the Reporting of Observational studies in Epidemiology (STROBE) guidelines.31 The findings presented are a subsection of a cross-sectional online survey, conducted by the EUROlinkCAT team, which explored the wider information and support needs of parents and carers of children with CAs in 10 European countries. This paper focuses on the healthcare experiences and health status of children during the COVID-19 pandemic, and parent and carer experiences of support. The survey was launched in the United Kingdom (UK) and Poland on 8th March 2021 and kept open until 14th July 2021. Ethics approval for the study was granted by the St George’s (University of London) Research Ethics Committee on 18th December 2020 (reference number: 2020.0311). Local ethics approvals (or evidence that no further approvals were required) were obtained from each participating country. The survey was launched in a staggered manner in each country, as and when translations were finalised and approvals granted (Table 1).

Table 1 Recruitment period and participant characteristics by country group.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Characteristic** | **All** | **UK** | **Poland** | **Germany** | **Croatia** | **Italy** | **Belgium/ Netherlands** | **Other EU†** |
| **Recruitment period**¥ |  |  |  |  |  |  |  |  |
| Start date | - | 8 Mar 2021 | 8 Mar 2021 | 11 May 2021 | 26 Apr 2021 | 16 Jun 2021 | 19 Apr 2021 | 6 Apr 2021 |
| End date | - | 14 Jul 2021 | 14 Jul 2021 | 14 Jul 2021 | 14 Jul 2021 | 31 Jul 2021 | 14 Jul 2021 | 14 Jul 2021 |
| **N** | 986 | 120 | 476 | 97 | 68 | 59 | 74 | 92 |
| **Age** |  |  |  |  |  |  |  |  |
| ≤30 | 162 (17%) | 18 (15%) | 93 (20%) | 13 (13%) | 8 (12%) | 4 (7%) | 15 (20%) | 11 (12%) |
| 31-40 | 516 (53%) | 53 (45%) | 264 (56%) | 51 (53%) | 37 (55%) | 27 (46%) | 35 (47%) | 49 (53%) |
| >40 | 301 (31%) | 47 (40%) | 115 (24%) | 33 (34%) | 22 (33%) | 28 (47%) | 24 (32%) | 34 (35%) |
| **Relation to child** |  |  |  |  |  |  |  |  |
| Mother | 911 (92%) | 116 (97%) | 449 (94%) | 81 (84%) | 63 (93%) | 52 (88%) | 64 (86%) | 86 (95%) |
| Father | 65 (7%) | 2 (2%) | 24 (5%) | 13 (13%) | 5 (7%) | 6 (10%) | 10 (14%) | 5 (5%) |
| Other‡ | 8 (1%) | 1 (1%) | 3 (1%) | 3 (3%) | - | 1 (2%) | - | - |
| **Employment** |  |  |  |  |  |  |  |  |
| Employed | 586 (60%) | 81 (68%) | 223 (47%) | 61 (62%) | 54 (79%) | 44 (75%) | 61 (82%) | 62 (69%) |
| Homemaker/carer | 301 (31%) | 36 (30%) | 198 (42%) | 27 (29%) | 7 (10%) | 11 (19%) | 8 (11%) | 14 (16%) |
| Other\* | 94 (9%) | 3 (3%) | 52 (11%) | 9 (9%) | 7 (10%) | 4 (7%) | 5 (7%) | 14 (16%) |
| **Education** |  |  |  |  |  |  |  |  |
| School ≤18 years | 390 (40%) | 44 (37%) | 163 (35%) | 61 (67%) | 19 (28%) | 30 (52%) | 44 (60%) | 29 (32%) |
| University | 482 (49%) | 50 (42%) | 257 (53%) | 27 (29%) | 45 (66%) | 19 (33%) | 29 (39%) | 55 (60%) |
| Post-graduate | 106 (11%) | 25 (21%) | 56 (11%) | 3 (3%) | 4 (6%) | 9 (16%) | 1 (1%) | 8 (9%) |
| **Migrant status** |  |  |  |  |  |  |  |  |
| >10 years/from birth | 924 (94%) | 111 (93%) | 467 (98%) | 86 (88%) | 64 (94%) | 50 (86%) | 71 (96%) | 75 (81%) |
| 6-10 years | 30 (3%) | 5 (4%) | 5 (1%) | 6 (7%) | 2 (3%) | 4 (7%) | 1 (1%) | 7 (8%) |
| 1-5 years | 28 (3%) | 4 (3%) | 2 (0.4%) | 5 (5% | 2 (3%) | 4 (7%) | 2 (3%) | 9 (10%) |
| <1 year | 2 (0.2%) | - | 1 (0.2%) | - | - | - | - | 1 (1%) |
| ¥The recall period for the survey items was from January 2020 until the time at which participants were recruited.  †Other European countries: Denmark (n=39), Portugal (n=23), Spain (n=16), Ireland (n=5), Bulgaria (n=2), Albania (n=1), Cyprus (n=1), Lithuania (n=1), Norway (n=1), Romania (n=1), Sweden (n=1), Ukraine (n=1).  ‡Other family member (n=3), legal guardian related to the child (n=2), legal guardian unrelated to the child (n=3).  \*Unemployed (n=56), long-term sick/disabled (n=17), on furlough (n=12), student (n=8), retired (n=1) | | | | | | | | |

## Participants

The survey was open to parents, carers, and guardians (termed henceforth as *parents*) of children up to 10 years of age who have one or more of the following CAs: cleft lip (with or without a cleft palate), spina bifida, CHD which required surgery, and Down syndrome. Due to the high level of heterogeneity across all CAs, these groups were pre-defined and selected to cover different types of impairments, with likely differing impacts on the experiences of the child and parent: (a) physical disability (spina bifida), (b) learning disability (Down syndrome), (c) visible defects (cleft lip), and (d) non-visible defects (CHD). Participants were actively recruited in 10 European countries: Belgium, Croatia, Denmark, Germany, Italy, Netherlands, Poland, Portugal, Spain, and the UK.

## Recruitment

Participants were recruited with convenience sampling which was conducted online via social media (Twitter and Facebook), charities and patient organisations within each participating country (e.g. the Down Syndrome Association in the UK), and closed support groups on Facebook. Potential participants were provided with a link to the survey website which included all language versions of the survey. Participants were provided with the participant information sheet at the start of the survey, and depending on local ethics requirements, participants were either required to complete an online consent form or consent was implied by completion of the survey. As the survey was shared across online platforms and by a number of international organisations (e.g. Down Syndrome International), responses were also received from parents living in other European countries (e.g. Ireland), and these were retained in the analysis.

## Survey

The content of the survey was developed following a literature review, and input from expert clinicians, parents and educators, academics with expertise in CA research and questionnaire development, and a Public Involvement and Community Engagement (PICE) lead. The survey included the following sections: (1) Parent Demographics (9 items), (2) Child Demographics and Medical Information (7 items), (3) Provision of Healthcare (7 items), (4) Impact on the Child (3 items), and (5) Support for Parents (2 items) (see Supplementary file). Response options varied and comprised: Yes-No (Provision of Healthcare), Not at all-A little-Quite a bit-Very much (Provision of Healthcare), Not at all satisfied-A little satisfied-Quite satisfied-Very satisfied (Support for Parents), and Much worse-Somewhat worse-About the same-Somewhat better-Much better (Impact on Child). All items were close-ended, therefore quantitative data were collected only. In relation to the timeframe, participants were asked to reflect on their experiences from the start of the pandemic in January 2020 to the time at which they completed the survey (March-July 2021).

### Translation

The survey was developed in English and translated into eight European languages following existing guidance.32 The Dutch version was used in Belgium and the Netherlands. The survey was initially translated into Polish and Italian to check for any translatability issues, and relevant amendments were subsequently made to the English version accordingly. These languages were selected because they have different origins (Slavic and Romance) with differing translation issues, and the research team included native Polish (ALB, AJ) and native English-Italian bilingual (EM) speakers. Translations were carried out in four steps for each language version: (1) a native speaker of the target language with good command of English conducted the initial translation, (2) the translation was checked by at least one other native speaker of the target language and any problems discussed and reconciled, (3) the survey was back-translated by a native English speaker (or person with a good command of the English language), and who was naïve to the original version, (4) the back-translated survey was reviewed by EM against the original English language version and any semantic or conceptual discrepancies in the back-translation were flagged and discussed with the translators until they were resolved. Due to differences in education systems across Europe, equivalent terminology for participants’ education level was not available, and categories were selected to reflect local education systems within each country.

### Data collection

Study data were collected and managed using Research Electronic Data Capture33 (REDCap) tools hosted at St George’s, University of London. All data collected were anonymous and it was therefore not possible to verify CA diagnoses. To keep the survey fully anonymous no internet protocol (IP) addresses were collected, so it was not possible to prevent multiple participation. Participants were initially allowed to skip any item, however, following an interim analysis on 27th April, a high proportion of missing data for country and CA type was noted. As these data were crucial to the research question, these two items were subsequently made mandatory.

## Patient and Public Involvement

People with experience in caring for or teaching children with CAs contributed to the development of the survey. These were (a) three parents of children with CAs who also run patient organisations/charities relevant to their child’s condition (Down syndrome, spina bifida, metachromatic leukodystrophy), (b) a clinical geneticist who works closely with a number of parent organisations, and (c) a teacher of children with special educational needs and disabilities. Each individual commented on an early draft of the survey, including the overall content of the survey, and the wording of questions and response options. This feedback was reviewed by the research team and relevant modifications were made to the draft survey to address it.

Findings from the study will be shared with members of the public, parents and carers, healthcare professionals and relevant stakeholders via scientific publications, lay reports, social media and conferences.

## Data analysis

Descriptive statistics were conducted using Stata 17.0 software.34 Data were checked to ensure that answers were consistent (e.g. identifying if a mother replying that she is 20-25 years old is retired). Outcomes scored on 4-point Likert scales (very much/satisfied vs. other responses) were dichotomised and outcomes scored on a 5-point Likert scale were collapsed into three categories by merging the two lowest response options (much worse, somewhat worse) and the two highest response options (much better, somewhat better). Data were modelled using multivariate logistic regressions and ordinal logistic regressions which included the child’s anomaly type, and parent’s country of residence, age and education level. The impact of country and anomaly type on outcomes was explored, choosing the largest categories as the comparator groups (Poland and CHD). For age and education, categorical data were collected. For the analysis each variable was re-coded into three groups: age (<30 years; 31-40 years, >40 years), education (formal education/technical training until 16 or 18 years; university degree; post-graduate degree). Age and education were included in our regression models as ordinal variables. To control for multiple comparisons, the alpha level was adjusted to p < 0.01 for all analyses. It was unlikely that data were missing at random so more sophisticated multiple imputation techniques were not adopted.

We aimed to recruit 80 participants per country which would have resulted in a power of 80% to determine that a country with 20% of participants replying category 4 (very much/satisfied) was statistically significantly different at the 95% level of significance from a country with 40% of participants replying category 4. Owing to delays in obtaining ethics approvals, this target was not met within the timescales for some countries. Data were presented by country if these were available for at least 50 participants. Where there were <50 participants, data were combined into an ‘other European country’ group (termed henceforth as *Other EU*), which included participants from a heterogenous group of countries. Due to similarities in survey responses, geographical location, and language, data for Belgium (n=46) and the Netherlands (n=28) were combined into a single group. For CAs, data were categorised according to the four anomalies, and a separate category created for children with Down syndrome and a CHD, a common co-morbidity.35 There were too few participants to create meaningful categories for children who had other combinations of the four anomalies (n=15), and these were excluded from the analysis.

Given that a multi-modal online recruitment strategy was used, it was not possible to estimate how many potential participants the survey reached in order to calculate response rates.36 Submission rates (number of participants who started the survey/number who completed and submitted the survey)37, and of those who submitted their survey, we calculated item-level response rates (proportion of participants completing each item)38 are reported.

# Results

## Participant characteristics

1,298 parents across Europe accessed the survey, of whom 1,109 (85%) submitted their responses. The submission rate ranged from 78% in Italy to 92% in Germany and Belgium. A further 123 (9.5%) submitted forms were not included in the analysis as country data were missing (n=80), CA data were missing (n=24), participants were from non-European countries (n=4) or participants specified different combinations of the four anomaly types (n=15). Item-level response rates were above 98% across all outcome variables.

Participants lived in Poland (n=476), the UK (n=120), Germany (n=97), Belgium/Netherlands (n=74), Croatia (n=68), Italy (n=59). The Other EU group (n=92) comprised participants from: Denmark (n=39), Portugal (n=23), Spain (n=16), Ireland (n=5), Bulgaria (n=2), Albania (n=1), Cyprus (n=1), Lithuania (n=1), Norway (n=1), Romania (n=1), Sweden (n=1), Ukraine (n=1). Most respondents were mothers (92%), aged 31-40 years (71%), and in full- or part-time employment (59%) (Table 1). In terms of education, 40% of participants had received formal education up to 16 or 18 years or technical training, 49% had a university degree, and 11% a post-graduate degree. Few participants had lived in their country of residence for <10 years (6%).

## Child characteristics

The largest CA group was CHD (n=327; 33%). Other children were diagnosed with Down syndrome (n=262; 26%), a cleft lip (n=230; 23%), spina bifida (n=112; 11%) and Down syndrome with a CHD (n=55; 6%). In terms of co-morbidities, 25% of children had another CA, and 43% had another health condition. The most common age category was 1-3 years (35%) and there was a slightly higher proportion of male children (56%). Just over a third of children attended school (36%), whereas 62% were not yet of school age, and 2% were either home-schooled or unable to be schooled due to their health status.

## (a) Provision of healthcare across countries

### Cancelled or postponed appointments

Cancellations or postponements of routine appointments were reported by 68% (623/920) of the whole sample, by 53% (427/803) for planned tests or procedures, and by 26% (121/609) for planned surgeries. The UK and Poland had the largest proportions of parents reporting cancelled or postponed appointments for each category (Figure 1). For routine appointments and planned tests/procedures, proportions were significantly lower in Germany, Croatia, Belgium/Netherlands, and the Other EU group compared with Poland (Table 2). For planned surgeries, all countries except the UK had a significantly lower proportion of cancelled or postponed appointments than Poland (full regression findings are available in the supplementary file).

Table 2 Proportion of participants reporting ‘cancelled or postponed’ routine appointments, planned tests or procedures, and planned surgeries, by country.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Country** | **Routine appointments**  **(N†=920)** | | **Planned tests or procedures (N†=803)** | | **Planned surgeries**  **(N†=609)** | |
| *Unadjusted* | *Adjusted\** | *Unadjusted* | *Adjusted\** | *Unadjusted* | *Adjusted\** |
| % [95% CI] | % [95% CI] | % [95% CI] | % [95% CI] | % [95% CI] | % [95% CI] |
| Poland | 79 [75-83] | 79 [75-83] | 66 [61-70] | 65 [60-70] | 37 [31-43] | 35 [29-41] |
| UK | 88 [82-94] | 86 [80-93] | 67 [58-76] | 67 [57-76] | 31 [20-41] | 33 [22-44] |
| Germany | 29 [19-38] | 31 [21-42] | 16 [8-24] | 18 [9-27] | 7 [1-14] | 8 [1-15] |
| Croatia | 46 [34-58] | 44 [32-56] | 36 [23-49] | 36 [23-49] | 14 [3-24] | 13 [3-24] |
| Italy | 69 [57-81] | 70 [58-82] | 52 [38-66] | 54 [40-68] | 9 [1-18] | 11 [0-20] |
| Belgium/Netherlands | 34 [23-46] | 39 [27-51] | 20 [9-31] | 23 [11-34] | 17 [7-27] | 16 [6-25] |
| Other EU | 56 [46-67] | 57 [47-67] | 43 [32-53] | 43 [32-53] | 12 [4-19] | 12 [4-20] |
| †Total number of participants excluding ‘not applicable’ responses. Missing data: routine appointments (9 participants), planned tests or procedures (8 participants), planned surgeries (5 participants).  \*Adjusted by congenital anomaly type, parental age, and education level.  CI = confidence intervals | | | | | | |

### Virtual appointments (by telephone or online)

Overall, 61% (544/891) of participants reported that their child’s face-to-face appointments had been rescheduled as virtual appointments. This proportion was highest in the UK (87%), significantly higher than in Poland (71%). In all other countries this proportion was significantly lower than Poland (Table 3).

Table 3 Proportion\* of participants reporting appointments rescheduled as virtual, virtual appointments rated as ‘poor’, and problems accessing medication, by country.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Country** | **Appointments rescheduled as virtual (N†=891)** | | **Virtual appointments rated as ‘poor’ (N†=552)** | | **Problems accessing medication (N†=713)** | |
| *Unadjusted* | *Adjusted\** | *Unadjusted* | *Adjusted\** | *Unadjusted* | *Adjusted\** |
| % [95% CI] | % [95% CI] | % [95% CI] | % [95% CI] | % [95% CI] | % [95% CI] |
| Poland | 72 [68-76] | 71 [67-75] | 37 [32-42] | 37 [32-43] | 34 [29-39] | 34 [29-39] |
| UK | 87 [81-93] | 87 [81-93] | 21 [13-29] | 21 [13-29] | 43 [33-54] | 42 [32-52] |
| Germany | 24 [15-33] | 25 [16-35] | 0 [0-17] | 0 [0-17] | 6 [1-12] | 7 [1-14] |
| Croatia | 46 [33-59] | 46 [33-58] | 15 [2-29] | 17 [2-31] | 5 [0-11] | 4 [0-10] |
| Italy | 34 [21-47] | 37 [23-50] | 29 [8-51] | 27 [7-48] | 14 [3-25] | 14 [3-25] |
| Belgium/Netherlands | 28 [17-40] | 34 [22-46] | 6 [0-18] | 5 [0-15] | 19 [8-29] | 19 [8-29] |
| Other EU | 50 [40-60] | 52 [42-62] | 23 [10-35] | 22 [10-34] | 9 [2-16] | 8 [2-14] |
| †Total number of participants excluding ‘not applicable’ responses. Missing data: appointments rescheduled as virtual (8 participants), virtual appointments rated as ‘poor’ (11 participants), problems accessing medication (8 participants).  \*Adjusted by congenital anomaly type, parental age and education level.  CI = confidence intervals | | | | | | |

Overall, 29% (159/541) of participants reported their child’s virtual appointments as being of ‘poor’ quality overall. This proportion was highest in Poland (37%), and significantly lower in the UK (21%), Belgium/Netherlands (5%), and Germany (0%) (Table 3). There was a significant impact of education level on ratings, whereby more highly educated participants were less likely to rate the overall quality of their virtual appointments as ‘poor’ (Odds Ratio [OR] = 0.55, 95% CI: 0.41-0.77; p=0.000).

### Access to medication

Overall, 26% (182/705) of participants reported some problems accessing medication for their child during the pandemic. This proportion was highest in the UK (42%) and Poland (34%) (Table 3). Italy (14%), the Other EU group (8%), Germany (7%), and Croatia (4%) all had significantly fewer participants reporting problems compared with Poland (Table 3).

## (b) Impact on the child’s health and wellbeing across countries

Overall, 30% (221/749) of participants reported that changes to their child’s treatment during the pandemic had moderately to severely compromised their child’s health. This figure was significantly higher in Poland (43%) compared with the UK (28%), the Other EU group (20%), Croatia (15%), Italy (12%), Germany (12%), and Belgium/Netherlands (7%) (Figure 2).

The majority of participants rated their child’s physical health (68%; 634/927) and emotional wellbeing (56%; 515/927) as being ‘about the same’ as it was prior to the pandemic. Overall, there was a greater proportion of participants who rated their child’s emotional wellbeing as ‘worse’ (35%; 319/927) compared to ‘worse’ ratings for physical health (17%; 162/927).

There was a significant impact of country on ratings for physical health, with all countries less likely to rate their child’s physical health as ‘worse’ than before the pandemic compared with Poland (Figure 3). Ratings for the impact of COVID-19 on emotional wellbeing were similar across countries.

## (c) Support for parents across countries

Overall, 23% (220/957) of participants reported that they would have liked more support during the pandemic ‘very much’. This proportion was highest in Poland (30%), and significantly lower in Croatia (14%), Belgium/Netherlands (9%), and the Other EU group (11%) (Figure 4). In terms of the source of support, satisfaction ratings were lowest for support from medical sources, and highest for people that participants had close relationships with, such as their partner (Table 4).

Table 4 Proportion\* of participants reporting that they were ‘very satisfied’ with the support they received from each source, by country.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Country** | **GP**  **(N†=775)** | **Specialist doctor/nurse**  **(N†=792)** | **Partner**  **(N†=868)** | **Friends/family**  **(N†=883)** | **Parents of children with same condition**  **(N†=637)** | **Patient organisations**  **(N†=510)** | **Schools**  **(N†=369)** |
| **%** [95% CI] | **%** [95% CI] | **%** [95% CI] | **%** [95% CI] | **%** [95% CI] | **%** [95% CI] | **%** [95% CI] |
| Poland | 26 [21-30] | 34 [27-37] | 69 [65-74] | 61 [56-66] | 66 [61-71] | 56 [50-62] | 27 [20-34] |
| UK | 25 [16-34] | 39 [29-49] | 79 [71-86] | 49 [40-58] | 51 [41-61 | 38 [27-48] | 47 [34-60] |
| Germany | 85 [76-94] | 84 [76-93] | 89 [81-97] | 73 [62-85] | 60 [42-79] | 59 [38-80] | 39 [17-61] |
| Croatia | 41 [28-53] | 46 [34-59] | 80 [1-90] | 64 [52-75] | 64 [51-76] | 36 [21-51] | 19 [2-36] |
| Italy | 44 [29-59] | 31 [16-45] | 71 [58-84] | 47 [32-61] | 44 [26-61] | 33 [18-49] | 42 [27-57] |
| Belgium/  Netherlands | 57 [44-72] | 59 [46-71] | 66 [54-77] | 49 [37-61] | 33 [17-50] | 14 [0-27] | 36 [20-52] |
| Other EU | 45 [33-57] | 45 [34-56] | 70 [60-79] | 52 [42-63] | 56 [43-68] | 38 [26-51] | 33 [19-46] |
| Total | 37 [33-40] | 42 [39-45] | 72 [70-75] | 58 [55-61] | 60 [56-64] | 46 [42-50] | 34 [29-38] |
| \*Adjusted by congenital anomaly type, parental age, and education level. Unadjusted proportions are not included in this table.  †Total number of participants completing the item, excluding ‘not applicable’ responses. Missing data: GP (n=10), specialist doctor/nurse (n=16), partner (n=11), friends/family (n=14), parents of children with same condition (n=17), patient organisations (n=18), schools (n=35).  CI = confidence interval; GP = general practitioner | | | | | | | | |

### Medical sources

The UK and Poland had the lowest proportion of ‘very satisfied’ ratings for GPs, 25% and 26% respectively (Table 4). Compared to Poland, ratings were significantly higher in Germany (85%) and the Other EU group (45%). Italy and Poland had the lowest ‘very satisfied’ ratings for specialist doctors/nurses, 31% and 32%, respectively. Compared to Poland, ratings were significantly higher in Germany (84%) and the Other EU group (45%) (Table 4).

### Organisations

The highest proportion of ‘very satisfied’ ratings for patient organisations were for parents in Germany (59%) and Poland (56%) (Table 4). Compared with Poland, these satisfaction ratings were significantly lower in the UK (38%) and Belgium/Netherlands (14%). The UK had the highest proportion of participants who were ‘very satisfied’ with support from their child’s school (47%), however, there were no significant country related effects.

### Close relationships

Poland had the highest proportion of ‘very satisfied’ ratings for support from parents of other children with the same health condition (66%), significantly higher than the UK (51%) and Belgium/Netherlands (33%) (Table 4). There were no significant differences in satisfaction ratings for support from ‘partner’ or ‘friends/family’ across countries.

## (d) Outcomes across CA types

There were few differences across CA types, with significant differences only found for items relating to the provision of healthcare. In summary, parents of children with CHD (43%) reported a significantly lower proportion of ‘cancelled or postponed’ tests/procedures compared with parents of children with spina bifida (65%) and Down syndrome (alone) (62%) (Table 5). The CHD group also reported significantly fewer rescheduled appointments (49%) compared with the Down syndrome with CHD (80%), Down syndrome (72%), and spina bifida (70%) groups (Table 5). A lower proportion of parents of children with a cleft lip (17%) reported problems accessing medication compared with the CHD group (34%) (Table 5).

Table 5 Proportion of participants reporting ‘cancelled or postponed’ planned tests/procedures, appointments rescheduled as virtual, virtual appointments rated as ‘poor’, and problems accessing medication, by CA type.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Congenital anomaly** | **Planned tests or procedures (N†=803)** | | **Appointments rescheduled as virtual (N†=891)** | | **Virtual appointments rated as ‘poor’ (N†=552)** | | **Problems accessing medication (N†=713)** | |
| *Unadjusted* | *Adjusted\** | *Unadjusted* | *Adjusted\** | *Unadjusted* | *Adjusted\** | *Unadjusted* | *Adjusted\** |
| % [95% CI] | % [95% CI] | % [95% CI] | % [95% CI | % [95% CI] | % [95% CI] | % [95% CI] | % [95% CI] |
| CHD | 42 [36-47] | 43 [37-49] | 46 [41-52] | 49 [44-55] | 36 [29-44] | 36 [28-44] | 31 [25-36] | 34 [21-40] |
| Cleft lip | 48 [41-55] | 51 [44-58] | 52 [45-58] | 56 [49-62] | 33 [24-42] | 29 [21-38] | 16 [9-22] | 17 [10-23] |
| Spina bifida | 64 [54-73] | 65 [56-73] | 66 [58-75] | 70 [62-77] | 30 [19-40] | 27 [17-37] | 30 [21-39] | 28 [19-36] |
| Down syndrome | 67 [61-73] | 62 [55-68] | 76 [71-81] | 72 [67-78] | 28 [21-34] | 29 [22-36] | 27 [20-33] | 24 [18-30] |
| Down syndrome with CHD | 60 [47-74] | 55 [40-68] | 83 [73-93] | 80 [69-91] | 33 [18-47] | 28 [13-42] | 20 [8-31] | 17 [6-27] |
| †Total number of participants excluding ‘not applicable’ responses. Missing data: planned tests/procedures (n=8), appointments rescheduled as virtual (n=8), virtual appointments rated as ‘poor’ (n=11), problems accessing medication (n=8).  \*Adjusted by parental country of residence, age, and education level.  CA = congenital anomaly; CI = confidence intervals; CHD=congenital heart defects | | | | | | | | |

# Discussion

## Main findings

This study provides a snapshot of the healthcare experiences of children with CAs, and their caregivers’ experiences of support across Europe, one year into the COVID-19 pandemic. Overall, many participants reported disruptions to their child’s routine care, which appeared to have an impact on the health of some children. Compared with non-medical organisations and parents’ close relationships, parents were least satisfied with support from GPs and specialist doctors/nurses, which was particularly poor in Poland and the UK. There were also regional differences in the proportions of parents reporting disruptions to healthcare, which again appeared most severe in Poland and the UK. Few differences were found in outcomes according to CA type, suggesting that the geographical location of participants had more of an influence on healthcare experiences than the child’s specific health condition.

Whilst acknowledging that a range of factors may underpin differences across countries (such as reductions in hospital visits to minimise infections), a possible hypothesis is that these are indicative of existing vulnerabilities within local healthcare systems, with lower resourced systems being less able to meet the needs of patients during the pandemic. In relation to the healthcare workforce, figures from the Organisation for Economic Co-operation and Development (OECD) in 2018 indicate that Poland had the lowest numbers of practising doctors per head in Europe (2.3/1,000), closely followed by the UK (2.8/1,000).39 In contrast, Germany had one of the highest numbers per head in Europe (4.4/1,000).39 Among European countries, Poland, Italy and the UK also had below average numbers of practicing nurses per head, a factor associated with patient satisfaction with care,40 which ranged from 5.1-7.8/1,000.39 In comparison, the Netherlands, Belgium, and Germany all had above average figures, 11.1, 11.2 and 13.1/1,000, respectively. A larger number of healthcare workers is likely to have helped with increased demand during the pandemic, and helped mitigate the consequences of staff sickness.39 Other factors that may account for regional differences include our method of recruitment and the severity of local restrictions. Participants were recruited with a consistent strategy across countries, however, some had a greater number of organsations who advertised the study and some were able to request that these organisations advertise the survey more frequently (for example in Poland). Recruitment periods also differed, ranging from 18 weeks in the UK and Poland to only 6.5 weeks in Italy (Table 1). As people are more likely to respond to surveys which are highly salient to their experiences,41 one might expect parents experiencing more challenges during the pandemic to have been more likely to respond. However, our survey was a general survey about parents’ information and support needs, with only one subsection relating to the pandemic, so this is unlikely. It is difficult to estimate the extent to which variations in the depth and duration of COVID-19 containment strategies might have influenced cross-country variations in outcomes. Containment strategies varied both regionally, within each country, and internationally, during the survey recall period (January 2020-July 2021). In addition, all countries experienced a period of full lockdown during this time frame, making these other variations less pertinent.

The use of virtual healthcare appointments during the pandemic meant parental concerns about cancellations could be addressed, whilst limiting their exposure to SARS-CoV-2.19 Around 60% of our sample reported that they had a face-to-face appointment re-scheduled as virtual. This was higher than other in other studies conducted with pediatric patients, which found that 11%18 and 20%42 of participants reporting re-scheduled appointments. However, these studies were conducted during the first wave of the pandemic (April-May 2020), a year before our survey was delivered, so this rise is not unexpected. The quality of virtual appointments was rated as ‘fair-excellent’ by two-thirds of our sample, whereas one third rated them as ‘poor’. This is in line with findings from a similar survey which found that 68% of CHD parents and patients described their virtual appointments as “adequate”.42 In contrast, other studies conducted within specialist pediatric centres found higher satisfaction ratings,19,43 such as 87% mean satisfaction ratings for virtual pediatric appointments.44 This increase, however, may be due to a slight social-desirability bias as parents were asked to rate satisfaction by staff within the specialist centres, whereas in our survey the recruiters were not involved in the child’s care. Of note is our finding whereby participants with a lower level of education were more likely to rate virtual appointments as poor.

## Strengths and limitations

This study surveyed parents and carers of children with different CA types within several countries, including a broad range of experiences. We recruited a large sample of parents and carers overall, and the proportion of each CA type reflects the relative number of live births with each CA in Europe.45 Although the survey was shared widely, the use of convenience sampling means there is a risk of selection bias, and the views and experiences of this sample may not be representative of all parents and carers of children with CAs. The use of social media to recruit participants may have excluded people living with ‘digital poverty’ and people who don’t tend to engage with these types of organisations, whose experiences may differ from this sample. When considering recruitment figures within each country these were mostly small. The survey was developed with input from parents of children with a CA, however, we were unable to conduct a full pilot of the final version. Great care was taken to avoid leading questions, ambiguity or complex language, however, it is possible that there may have been some issues with the wording or content of survey items.

## Implications and future research

Our survey findings are important and provide useful insights into the provision of care for children with CAs across Europe during the first year of the pandemic. Findings highlight potential weaknesses of healthcare systems in some countries and suggest that long-term systemic action is required to improve patient experiences and outcomes. The situation appears particularly problematic in the UK and Poland, which may benefit from increased resources to provide for this vulnerable group of patients. Patient organisations and charities provide an invaluable source of knowledge and support to parents of children with CAs, and these should be supported, especially in countries where medical capacity to meet patients’ needs may be stretched.

As with many other patient groups, it is clear that the COVID-19 pandemic has had an impact on the experiences of children living with a serious health condition and their families.20,46,47 This particular survey suggests disruptions to care for children, with potential impacts on the child’s health and well-being. Considering the limitations of this study, it will be important to further investigate the impact of the COVID-19 pandemic on the delivery of paediatric services across Europe using population-based data. With the proliferation of telemedicine to deliver care during the pandemic,44 exploring the reasons why these virtual strategies were lacking for some parents (particularly those with a lower level of education) is important to ensure optimal parental satisfaction with future care and support from medical professionals.

# Conclusion

The COVID-19 pandemic continues to put pressure on healthcare systems worldwide. Our survey findings highlight disruptions to the delivery of care across Europe, particularly in the UK and Poland, which raises questions about the ability of the healthcare systems within these countries to meet the needs of children with CAs and their families, and a need for increased resources.

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Ethics approval for the study was granted by the St George’s (University of London) Research Ethics Committee on 18th December 2020 (reference number: 2020.0311). In Poland, ethics approval was granted on 10**th** December 2020 by the Bioethics Committee at the Poznań University of Medical Sciences (reference number: 882/20). In Croatia, ethics approval was granted on 10th December 2020 by the Ethics Committee of the Children’s Hospital Zagreb (Protocol No: 02-23/43-1-20 Zagreb). In Spain, ethics approval was granted on 21st December 2020 by the Clinical Investigation Ethics Committee of the “Dirección General de Salud Pública y Centro Superior de Investigación en Salud Pública” (reference number: 20201221/05). In Belgium, ethics approval was granted on 1st March 2021 by the Ethics Committee of the University Hospital of Antwerp (reference: 21/06/084). In Portugal, ethics approval was granted on 16th March by the Ethics Committee of the National Institute of Health Doutor Ricardo Jorge (CES-INSA). In Germany, ethics approval was granted on 15th April 2021 by the Medical Faculty of the Otto-von-Guericke-University Magdeburg Research Ethics Committee (reference number: 44/21). In Italy, ethics approval was granted on 14th June 2021 by the Research Ethics and Integrity Committee of the National Research Council Institute of Clinical Physiology in Pisa (CNR-INF) (protocol number 0065527/2019). No local ethics approvals were required in Denmark (Lillebaelt Hospital – University Hospital of Southern Denmark) or the Netherlands (University Medical Center Groningen).

# Data availability statement

The datasets analysed during the current study are available from the corresponding author on reasonable request.

# Contributers

ALB conceptualised the study. ALB, EM, and JKM contributed to the study design. EM led the survey development, translation, and recruitment of participants. EM and JKM conducted the data analysis. ALB, JKM, and JR critically revised the manuscript. AJD, IB, CCC, EDH, EG, EM, LG, AJS, RT, CMD, LRL, CNP, AJN, AN, LO, LPR, AP, and AR oversaw the translation of the survey and recruited participants. EM drafted the manuscript. All authors contributed to, read and approved the final manuscript.

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# Competing interests

All authors have completed the ICMJE uniform disclosure form at <http://www.icmje.org/disclosure-of-interest/> and declare: all authors had financial support from the European Union’s Horizon 2020 research and innovation programme for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

# Transparency declaration

The corresponding author affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

# Dissemination to study participants and related patient and patient communities

Findings from the study will be shared with members of the public, parents and carers, healthcare professionals and relevant stakeholders via scientific publications, lay reports, social media, and conferences.

# References

1 Smolic, S., Cipin, I. & Medimurec, P. Access to healthcare for people aged 50+ in Europe during the COVID-19 outbreak. *European Journal of Ageing*, 1-17, doi:10.1007/s10433-021-00631-9 (2021).

2 Cena, L., Rota, M., Calza, S. *et al.* Estimating the Impact of the COVID-19 Pandemic on Maternal and Perinatal Health Care Services in Italy: Results of a Self-Administered Survey. *Frontiers in Public Health* **9**, 701638, doi:10.3389/fpubh.2021.701638 (2021).

3 van Veenendaal, N. R., Deierl, A., Bacchini, F. *et al.* Supporting parents as essential care partners in neonatal units during the SARS-CoV-2 pandemic. *Acta Paediatr* **110**, 2008-2022, doi:10.1111/apa.15857 (2021).

4 Gardner, T. & Fraser, C. Elective care: how has COVID-19 affected the waiting list? London: The Health Foundation. Available from: <https://bit.ly/3EKqvRL> [accessed 1 Nov 2021] (2021).

5 Chiumento, A., Baines, P., Redhead, C. *et al.* Which ethical values underpin England’s National Health Service reset of paediatric and maternity services following COVID-19: a rapid review. *BMJ Open* **11**, e049214, doi:10.1136/bmjopen-2021-049214 (2021).

6 Colvin, L. & Bower, C. A retrospective population-based study of childhood hospital admissions with record linkage to a birth defects registry. *BMC Pediatr* **9**, 32, doi:10.1186/1471-2431-9-32 (2009).

7 Rosano, A., Botto, L. D., Botting, B. *et al.* Infant mortality and congenital anomalies from 1950 to 1994: an international perspective. *Journal of Epidemiology and Community Health* **54**, 660-666, doi:10.1136/jech.54.9.660 (2000).

8 Department of Health. *National framework for children and young peoples continuing care*. (Department of Health, London, 2016).

9 Razzaghi, H., Dawson, A., Grosse, S. D. *et al.* Factors associated with high hospital resource use in a population-based study of children with orofacial clefts. *Birth Defects Res A Clin Mol Teratol* **103**, 127-143, doi:10.1002/bdra.23356 (2015).

10 Fitzgerald, P., Leonard, H., Pikora, T. J. *et al.* Hospital admissions in children with down syndrome: experience of a population-based cohort followed from birth. *PLoS ONE* **8**, e70401, doi:10.1371/journal.pone.0070401 (2013).

11 Bishop, C. F., Small, N., Parslow, R. *et al.* Healthcare use for children with complex needs: using routine health data linked to a multiethnic, ongoing birth cohort. *BMJ Open* **8**, e018419, doi:10.1136/bmjopen-2017-018419 (2018).

12 Alanazi, A. F., Naser, A. Y., Pakan, P. *et al.* Trends of Hospital Admissions Due to Congenital Anomalies in England and Wales between 1999 and 2019: An Ecological Study. *International Journal of Environmental Research and Public Health* **18**, 11808, doi:10.3390/ijerph182211808 (2021).

13 Ludvigsson, J. F. Systematic review of COVID-19 in children shows milder cases and a better prognosis than adults. *Acta Paediatr* **109**, 1088-1095, doi:10.1111/apa.15270 (2020).

14 Malle, L., Gao, C., Hur, C. *et al.* Individuals with Down syndrome hospitalized with COVID-19 have more severe disease. *Genet Med* **23**, 576-580, doi:10.1038/s41436-020-01004-w (2021).

15 Clift, A. K., Coupland, C. A. C., Keogh, R. H. *et al.* COVID-19 Mortality Risk in Down Syndrome: Results From a Cohort Study of 8 Million Adults. *Ann Intern Med* **174**, 572-576, doi:10.7326/M20-4986 (2021).

16 Malviya, A. & Yadav, R. COVID -19 pandemic and paediatric population with special reference to congenital heart disease. *Indian Heart J* **72**, 141-144, doi:10.1016/j.ihj.2020.06.001 (2020).

17 Madhusoodhan, P. P., Pierro, J., Musante, J. *et al.* Characterization of COVID-19 disease in pediatric oncology patients: The New York-New Jersey regional experience. *Pediatr Blood Cancer* **68**, e28843, doi:10.1002/pbc.28843 (2021).

18 Poppe, M., Aguiar, B., Sousa, R. *et al.* The Impact of the COVID-19 Pandemic on Children's Health in Portugal: The Parental Perspective. *Acta Med Port* **34**, 355-361, doi:<https://dx.doi.org/10.20344/amp.14805> (2021).

19 Darr, A., Senior, A., Argyriou, K. *et al.* The impact of the coronavirus (COVID-19) pandemic on elective paediatric otolaryngology outpatient services - An analysis of virtual outpatient clinics in a tertiary referral centre using the modified paediatric otolaryngology telemedicine satisfaction survey (POTSS). *Int J Pediatr Otorhinolaryngol* **138**, 110383, doi:<https://dx.doi.org/10.1016/j.ijporl.2020.110383> (2020).

20 Wray, J., Pagel, C., Chester, A. H. *et al.* What was the impact of the first wave of COVID-19 on the delivery of care to children and adults with congenital heart disease? A qualitative study using online forums. *BMJ Open* **11**, e049006, doi:10.1136/bmjopen-2021-049006 (2021).

21 The Cleft Lip and Palate Association. Summer Survey 2020: The Results. Available from: <https://www.clapa.com/news-item/summer-survey-2020-the-results/> [accessed 2 Nov 2021]. (2020).

22 Marino, L. V., Wagland, R., Culliford, D. J. *et al.* "No Official Help Is Available"-Experience of Parents and Children With Congenital Heart Disease During COVID-19. *World Journal for Pediatric & Congenital Heart Surgery* **12**, 500-507, doi:<https://dx.doi.org/10.1177/21501351211007102> (2021).

23 Cousino, M. K., Pasquali, S. K., Romano, J. C. *et al.* Impact of the COVID-19 pandemic on CHD care and emotional wellbeing. *Cardiol Young* **31**, 822-828, doi:10.1017/S1047951120004758 (2021).

24 Stewart, A., Smith, C. H., Eaton, S. *et al.* COVID-19 pandemic experiences of parents caring for children with oesophageal atresia/tracheo-oesophageal fistula. *BMJ Paediatr Open* **5**, e001077, doi:10.1136/bmjpo-2021-001077 (2021).

25 Mongru, R., Rose, D., Costelloe, C. *et al.* Retrospective analysis of North West London healthcare utilisation by children during the COVID-19 pandemic. *BMJ Paediatrics Open* **6**, e001363, doi:10.1136/bmjpo-2021-001363 (2022).

26 Kruizinga, M. D., Peeters, D., van Veen, M. *et al.* The impact of lockdown on pediatric ED visits and hospital admissions during the COVID19 pandemic: a multicenter analysis and review of the literature. *Eur J Pediatr* **180**, 2271-2279, doi:10.1007/s00431-021-04015-0 (2021).

27 Nicholson, E., McDonnell, T., Conlon, C. *et al.* Parental Hesitancy and Concerns around Accessing Paediatric Unscheduled Healthcare during COVID-19: A Cross-Sectional Survey. *Int J Environ Res Public Health* **17**, 11, doi:<https://dx.doi.org/10.3390/ijerph17249264> (2020).

28 Liguoro, I., Pilotto, C., Vergine, M. *et al.* The impact of COVID-19 on a tertiary care pediatric emergency department. *Eur J Pediatr* **180**, 1497-1504, doi:<https://dx.doi.org/10.1007/s00431-020-03909-9> (2021).

29 Dorfman, L., Nassar, R., Binjamin Ohana, D. *et al.* Pediatric inflammatory bowel disease and the effect of COVID-19 pandemic on treatment adherence and patients' behavior. *Pediatric Research* **90**, 637-641, doi:<https://dx.doi.org/10.1038/s41390-020-01312-6> (2021).

30 Morris, J. K., Garne, E., Loane, M. *et al.* EUROlinkCAT protocol for a European population-based data linkage study investigating the survival, morbidity and education of children with congenital anomalies. *BMJ Open* **11**, e047859, doi:10.1136/bmjopen-2020-047859 (2021).

31 Cuschieri, S. The STROBE guidelines. *Saudi J Anaesth* **13**, S31-S34, doi:10.4103/sja.SJA\_543\_18 (2019).

32 Kuliś, D., Bottomley, A., Velikova, G. *et al.* EORTC Quality of Life Group Translation Procedure (4th edition). Available from: <https://www.eortc.org/app/uploads/sites/2/2018/02/translation_manual_2017.pdf> [accessed 14 Nov 2021]. (2017).

33 Harris, P. A., Taylor, R., Thielke, R. *et al.* Research electronic data capture (REDCap)--a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform* **42**, 377-381, doi:10.1016/j.jbi.2008.08.010 (2009).

34 Stata Statistical Software: Release 17 (College Station, TX: StataCorp LLC, 2021).

35 Leirgul, E., Fomina, T., Brodwall, K. *et al.* Birth prevalence of congenital heart defects in Norway 1994–2009 - a nationwide study. *Am Heart J* **168**, 956-964 (2014).

36 McRobert, C. J., Hill, J. C., Smale, T. *et al.* A multi-modal recruitment strategy using social media and internet-mediated methods to recruit a multidisciplinary, international sample of clinicians to an online research study. *PLoS ONE* **13**, e0200184, doi:10.1371/journal.pone.0200184 (2018).

37 Liu, M. & Wronski, L. Examining completion rates in web surveys via over 25,000 real-world surveys. *Social Science Computer Review* **36**, 116-124 (2018).

38 Bosnjak, M. & Tuten, T. L. Classifying Response Behaviors in Web-based Surveys. *Journal of Computer-Mediated Communication* **6** (2001).

39 OECD & European Union. Health at a Glance: Europe 2020. State of Health in the EU Cycle. OECD Publishing; Paris. Available from: <https://doi.org/10.1787/82129230-en> [accessed 26 Nov 2021]. (2020).

40 Aiken, L. H., Sloane, D. M., Ball, J. *et al.* Patient satisfaction with hospital care and nurses in England: an observational study. *BMJ Open* **8**, e019189, doi:10.1136/bmjopen-2017-019189 (2018).

41 Saliba, W. & Ostojic, P. Personality and participation: who volunteers to participate in studies. *Psychology* **5**, 230-243, doi:10.4236/psych.2014.53034 (2014).

42 Cousino, M. K., Pasquali, S. K., Romano, J. C. *et al.* Impact of the COVID-19 pandemic on CHD care and emotional wellbeing. *Cardiol Young* **31**, 822-828, doi:<https://dx.doi.org/10.1017/S1047951120004758> (2021).

43 Gali, K., Joshi, S., Hueneke, S. *et al.* Barriers, access and management of paediatric epilepsy with telehealth. *J Telemed Telecare* **28**, 213-223, doi:<https://dx.doi.org/10.1177/1357633X20969531> (2022).

44 Pooni, R., Pageler, N. M., Sandborg, C. *et al.* Pediatric subspecialty telemedicine use from the patient and provider perspective. *Pediatric Research* **91**, 241-246, doi:<https://dx.doi.org/10.1038/s41390-021-01443-4> (2022).

45 European Commission and EUROCAT. Prevalence charts and data on congenital anomalies. Available from: <https://eu-rd-platform.jrc.ec.europa.eu/eurocat/eurocat-data/prevalence_en> [accessed 30 Nov 2021] (2021).

46 Marino, L. V., Wagland, R., Culliford, D. J. *et al.* "No Official Help Is Available"-Experience of Parents and Children With Congenital Heart Disease During COVID-19. *World Journal for Pediatric and Congenital Heart Surgery* **12**, 500-507, doi:10.1177/21501351211007102 (2021).

47 Darlington, A., Morgan, J., Wagland, R. *et al.* COVID-19 and children with cancer: Parents’ experiences, anxieties and support needs. *Pediatr Blood Cancer* **68**, e28790, doi:10.1002/pbc.28790 (2021).

# Figure legend

Figure 1 Proportion\* of participants reporting ‘cancelled or postponed’ routine appointments, planned tests or procedures, and planned surgeries with 95% confidence intervals, by country.

\*Adjusted by congenital anomaly type, parental age, and education level.

Figure 2 Proportion\* of participants reporting that their child’s health had been ‘moderately to severely’ compromised following changes to their child’s treatment with 95% confidence intervals, by country.

\*Adjusted by congenital anomaly type, parental age, and education level.

Figure 3 Proportion\* of participants reporting that their child’s physical health was ‘worse’, ‘about the same’ or ‘better’ than it was prior to the pandemic with 95% confidence intervals, by country.

\*Adjusted by congenital anomaly type, parental age, and education level.

Figure 4 Proportion\* of participants reporting they would have liked more support during the pandemic ‘very much’ with 95% confidence intervals, by country.

\*Adjusted by congenital anomaly type, parental age, and education level.