Hospitalisations for physical abuse in infants and children less than 5 years, 2013–2021: a multinational cohort study using administrative data from five European countries

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Summary

Background Child physical abuse (CPA) is a global public health problem associated with lifelong negative consequences, yet reliable epidemiologic data are lacking. This multinational cohort study analyses trends in CPA hospitalisations from 2013 to 2021.

Methods We used medico-administrative databases to identify children aged one month to five years hospitalised in Denmark, England, France, Ireland, and Wales. We identified CPA using a validated algorithm based on ICD-10 codes. We calculated the number, proportion, and incidence rate of children hospitalised for CPA, and the number and proportion of total hospitalisations for CPA, by year and age group (<1 and <5). We determined the proportion of CPA hospitalisations recorded using different ICD-10 codes, by country.

Findings The pooled incidence rate of infants <1 year hospitalised for CPA was stable over time (around 42/100,000 per year), ranging on average from 33 to 48/100,000 between countries. The pooled proportion of infant hospitalisations for CPA was around 0.17% (N = 750) per year (range 0.15–0.21%, N range 674–785), increasing significantly during the COVID-19 pandemic in 2020 (0.21%, N = 674). In children <5, the incidence rate (around 18/100,000 per year) and proportion of CPA hospitalisations (around 0.11% per year (N = 1600), range 0.10–0.14% (N range 1341–1657) were lower than in infants, but also increased in 2020 (0.14%, N = 1341). There were national differences in the distribution of ICD-10 codes used to record CPA and differences in year-on-year trends between countries.

Interpretation Comparing temporal trends in CPA hospitalisations between countries is feasible. Hospital data are one of several valuable sources for CPA surveillance.

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Research in context

Evidence before this study

Several systematic reviews have examined the nationwide prevalence of child physical abuse (CPA) in different countries, but these are largely based on self-reported or informant-reported data. We looked for quantitative studies that used administrative data to compare trends in CPA hospitalisations in different countries. We searched Embase, Medline, Global Health, AMED, and CAB Abstracts up to 20 January, 2024 (with no specified earliest date), with the following search terms: "child abuse and neglect", "child maltreatment", "child abuse", "violence against children", "child physical abuse", "hospitali?ation", "hospital*", "hospital databas*", "administrative data records", "routinely collected data", "population-based record linkage", "data linkage stud*". Several studies have investigated the epidemiology of CPA hospitalisations using administrative data in individual countries, however few have compared trends over time between countries. One study compared trends in CPA hospitalisations across six different countries including the United States, Canada, New Zealand, Australia, the United Kingdom, and Sweden. Two studies compared CPA hospitalisations between England and Scotland, and England and Western Australia, respectively. There were no studies comparing trends in CPA hospitalisations in more than two European countries.

Added value of this study

This study is, to our knowledge, the first large-scale analysis examining trends in hospitalisations for CPA in more than two European countries. Using nationwide administrative hospital data from five countries (Denmark, England, France, Ireland, and Wales) over a nine-year period (2013–2021), we examined the annual incidence rate of CPA hospitalisations amongst infants <1 year and children <5 years, by country. In addition, we examined hospitalisations attributed to CPA as a proportion of the total number of hospitalisations, and assessed the distribution of International Classification of Diseases-10 codes used to identify CPA in each country. Applying a standardised approach enabled us to pool the data to produce overall figures. Pooled incidence rates and pooled proportions of CPA hospitalisations were higher in infants than in children <5 years. Pooled incidence rates were stable over time in both age groups, and annual incidence rates were similar overall between countries, particularly for infants, however year-on-year trends appeared to differ by country. On average, incidence rates for infants were highest in England and lowest in Wales, but for children <5 these rates were highest in England and Wales and lowest in France. The pooled proportion of CPA hospitalisations increased significantly during the COVID-19 pandemic in 2020 and this applied in all countries. On average, proportions of hospitalisations for CPA in infants were highest in France and lowest in Wales, but for children <5 they were highest in England and lowest in Ireland. The distribution of ICD-10 codes used to record CPA differed by country.

Implications of all the available evidence

Although CPA is associated with significant health, social, and educational consequences, evidence on hospitalisations for CPA is scarce. We analysed data on more than 12 million hospitalisations to describe temporal trends in CPA hospitalisations in multiple European countries. This study demonstrates that it is feasible to compare temporal trends in CPA hospitalisations between countries using a standardised approach, which implies that administrative hospital data is one of several valuable sources of information for surveillance of CPA. The pooled incidence rates of CPA remained stable over time, highlighting that CPA in Europe is clearly a pressing and on-going public health issue. The increase in the proportion of CPA hospitalisations in 2020 is likely due to a reduction in overall hospital admissions during COVID-19. We recommend that all European countries make their individual-level data on CPA hospitalisations accessible to researchers to facilitate further comparative and pooled analyses. Data on trends in CPA hospitalisations can inform the public health response to CPA and can assist policymakers in developing and implementing targeted prevention strategies in line with the United Nations 2030 Sustainable Development Agenda.

Introduction

Child physical abuse (CPA) is a major global public health problem that can have far-reaching and lifelong negative consequences.[1] A systematic review of self-report data estimated that CPA affects 22.6% of children aged 0–18 in Europe,[2] and a recent study conducted in the United States found a prevalence of 27–29% among children aged 0–4 years.[3] Overall, it is estimated that as many as half of all children less than five years of age worldwide have experienced physical punishment.[4] CPA can lead to severe long-term outcomes, including mental health disorders, behavioural issues, and suicide.[5] Moreover, it has negative impacts on physical health, contributing to the development of chronic illnesses including cancer, fibromyalgia, and ischaemic heart disease.[5] CPA is also associated with an increased risk of premature death in adulthood.[6] These detrimental effects on physical and mental health are a

significant social and economic burden that manifests through increased use of healthcare services and formal social support, and productivity losses throughout adult life.[7] Within a public health framework, the investigation of CPA can be conceptualised as a four-step process, whereby the first step is to define the problem through data collection and surveillance efforts.[8] Public health surveillance initiatives describe the burden of an issue within a population and monitor geographic and temporal trends in its occurrence. Policymakers and researchers can then use surveillance data to plan services, interventions, and prevention programmes, and predict future need.

Identification of CPA is particularly important for children hospitalised with severe injuries, to prevent further serious harm or death. Among severely injured children admitted to hospital, infants less than one year of age are more likely to have suffered abuse than older children.[9] A study of almost 15,000 children included in the national trauma registry of England and Wales (TARN) database found that almost all (97.7%) children severely injured due to suspected CPA were aged 0–5 years, and 76.3% were aged less than one year.[10] Suspected abuse victims have higher injury severity scores and are more likely to die compared to children with accidental injuries.[10]

Medico-administrative databases are valuable sources for the surveillance of CPA.[11] Administrative hospital data coded using the International Classification of Diseases (ICD) system provide an internationally standardised data source for categorising and recording diseases, injuries, external causes of injuries, and related health conditions for reporting and monitoring purposes.[12] Children who have been physically abused may be admitted to hospital with clear signs of trauma such as bruising, fractures, burns, or retinal haemorrhages, which, in the absence of a witnessed accident, plausible explanation, or medical condition, can serve as objective diagnostic criteria for CPA.[13] ICD codes are used to record diagnoses as part of routine medical care and can therefore identify children who have been hospitalised due to physical abuse. However, despite their utility, research has shown that ICD codes are used inconsistently across countries, which hinders efforts to pool and compare data internationally.[14] This underscores the need to map how different European countries are using ICD codes for CPA surveillance.

While several population-based studies have used administrative hospital data to investigate the epidemiology of CPA hospitalisations in individual European and non-European countries, including France,[15] England,[16] the United States,[17,18] Australia,[19] and Taiwan,[20] very few studies have compared trends in CPA hospitalisations over time between countries.[21–23] Given the rarity of CPA in hospital settings and the small populations of some countries, trends in single-country data can be vulnerable to fluctuations simply due to random variation over time. Comparative analysis of CPA data across multiple countries mitigates the risk of misinterpreting random variations as genuine epidemiological trends. Comparative approaches allow researchers to assess whether patterns are consistent across different settings, and better identify whether observed changes reflect broader, systemic factors or are limited to specific local conditions.

To our knowledge, there are no published studies comparing trends in CPA hospitalisations over time in more than two European countries. Therefore, the primary aim of this study was to use nationwide administrative hospital data to analyse and compare trends in CPA hospitalisations in five European countries participating in Working Group 2 of the Euro-CAN COST Action 19,106 network (www.euro-can.org). The secondary aim was to describe the distribution of ICD-10 codes used to record CPA in each country.

Methods

Study design and data sources

We conducted a multinational cohort study using administrative data from five European countries: Denmark, England, France, Ireland, and Wales. We selected these countries based on the affiliations of members of Working Group 2 and considerations relating to the ease of accessing data. The research used each nation's centralised repository of administrative and medical data which records every hospital stay on a national level. Diagnoses identified during the hospital stay are coded with ICD-10 codes.

For Denmark: Data on diagnoses, based on ICD-10 codes, were extracted from the Danish National Patient Registry, covering hospital admissions since 1977 and all contacts since 1995.[24] Birth data were obtained from the Medical Birth Register and death dates from the Civil Registration System. We obtained general population estimates from publicly available data provided by Statistics Denmark. The validated Danish registries continuously collect healthcare data. Ethical approval is not required for register-based studies in Denmark. Data use was approved by the Capital Region's responsible institute (P-2019–280) in accordance with the General Data Protection Regulation.

For England: We used the National Health Service (NHS) Hospital Episode Statistics Admitted Patient Care (HES APC) dataset, covering hospital admissions since 1997.[25] HES APC data are collected on all admissions to NHS hospitals in England and some independent sector providers paid for by the NHS (e.g. private or charitable hospitals). The data covers 98–99% of hospital activity in England and includes hospital admissions, e.g. any secondary care based-activity requiring a hospital bed. We took general population estimates from the Office of National Statistics mid-year population estimates.[26]

For France: The SNDS (Système National des Données de Santé) is the French national information system that contains individual, extensive, and linkable but anonymous data on healthcare use. In this work, we used data corresponding to the national hospital discharge database implemented in 1996, which is incorporated into the SNDS and includes discharge abstracts for all inpatient admissions to public and private hospitals in France.[27] We did all analyses using a specific server that is authorised to manage this pseudonymised national database. Quality assurance was provided by the national health insurance scheme, which is responsible for the SNDS database. We took general population estimates from the census data of the French national institute of statistics and Economic Studies (INSEE).

For Wales: Data on all hospital admissions in Wales are held in the Patient Episode Database for Wales (PEDW), implemented in 1991.[28] This contains data for inpatient and day cases within NHS Wales and for Welsh residents treated in English Trusts. Records are based on consultant episodes, defined as periods of continuous care during which a patient is under the care of one consultant within one NHS provider. Multiple diagnostic and procedure codes can be recorded within each episode. Anonymised PEDW data are deposited into the Secure Anonymised Information Linkage (SAIL) Databank, an accredited Trusted Research Environment, and researchers apply for access to the individual-level, anonymised data by following a series of established governance processes.[29] The Welsh Demographic Service Dataset (WDSD) was used for general population estimates; this is a register of all individuals registered with a Welsh General Practice.

For Ireland: In Ireland, the Health Pricing Office is responsible for managing and reporting data from the Hospital In-Patient Enquiry (HIPE) scheme established in 1971. HIPE is a health information system designed to collect medical and administrative data on discharges from, and deaths in, acute public hospitals.[30] Each HIPE discharge record represents one episode of care. Patients may be admitted to hospital more than once in any given period with the same or different diagnoses. In the absence of a unique health identifier, the data reported to HIPE facilitate analysis of hospital discharge activity, but do not permit analysis of discharges at individual patient level. Consequently, HIPE data cannot be used to examine certain parameters such as the number of hospital encounters per patient, or as proxies for incidence or prevalence.

Study population

This multinational study included all children aged more than one month and less than five years with at least one hospitalisation from January 1, 2013 to December 31, 2021 in any of the five European countries. Results are provided for children <5 years and infants <1 year. We chose these age groups as they are the ones most commonly used in the literature and the age groups in which our algorithm for identifying CPA was validated (see *Measures* section below). In addition, we examined infants <1 year separately as the incidence of CPA is highest in this age group. Infants younger than one month were excluded given the challenges associated with identifying abuse in children with perinatal obstetric injuries and congenital conditions.[15]

Measures

The primary outcome was hospital-recorded CPA, identified using a validated algorithm developed in a previous study.[15] The algorithm, which was validated in France, has a positive predictive value of 94.4% and 86.3% for identifying CPA in infants <1 year and children <5 years, respectively.[31] It is based on ICD-10 codes used to record diagnoses of CPA, specifically those indicating intentional physical assault (Table S1).

The secondary outcome was the proportion of CPA hospitalisations identified by each ICD-10 code by country.

Statistical analysis

Main objective: trends in child physical abuse

We examined CPA trends in each country from 2013 to 2021, using both children and hospital stays as units of analysis.

We first used children as the unit of analysis considering the first hospitalisation of each child per calendar year, regardless of whether they were hospitalised multiple times per year, and calculated the following annual metrics: (1) the number of children hospitalised for CPA; (2) the incidence rate of CPA hospitalisations per 100,000 resident children; (3) the number of children hospitalised for any reason; and (4) the proportion of CPA hospitalisations, calculated by dividing the number of children hospitalised for CPA by the total number of children hospitalised for any reason. Ireland was not included in these analyses due to the absence of unique identifiers.

Using hospital stays as the unit of analysis, we calculated the following metrics for each calendar year: (1) the number of hospitalisations for CPA; (2) the number of hospitalisations for any reason; (3) the proportion of hospitalisations for CPA among all hospitalisations.

The results from the five countries were pooled to generate overall findings. These analyses were initially performed for infants (children aged greater than one month and less than one year). We then performed the same calculations for children aged greater than one month and less than five years, to examine whether trends were similar for the two age groups.

For all pooled incidence rates and proportions, we presented the corresponding 95% confidence intervals. We analysed variations in these rates and proportions over time using the Cochran–Armitage test. To test for a

variation in the tendency of changes in relation with the COVID-19 pandemic in 2020, we performed interrupted time-series analysis (ITS), a segmented regression approach.[32] This ITS analysis was performed using a join point regression with autoregressive error terms, with the errors assumed to follow a second-order (lag time) autoregressive process (PROC AUTOREG in SAS software). We estimated the impact of the COVID-19 pandemic in 2020 in the proportion of CPA based on annual measures taken before and after 2020. This model compared slopes of best-fit lines through the pre- and post-period outcomes separately to detect differences. The impact of the interruption is modeled with a step function variable, an indicator that is zero in all periods before the interruption and one afterwards. Parameter estimates were calculated using the exact maximum likelihood method. To examine differences in pooled incidence rates and proportions for 2020 compared to previous years, we performed Pearson Chi-squared tests. Specifically, we compared: (1) 2020 versus 2019; (2) 2020 versus the mean rate for 2013–2019; and (3) 2020 versus the median rate for 2013–2019. To account for differences in effect in each country, we also performed Mantel-Haenszel Chi-squared tests and Poisson regressions. We tested for interactions between country and year. Statistical significance was set at $p < 0.05$.

Finally, we determined whether annual incidence rates differed significantly by country by examining whether the 95% confidence intervals overlapped with one another.

Secondary objective: distribution of ICD-10 codes used to identify child physical abuse

The distribution of CPA-attributable ICD-10 codes was calculated as the proportion of each code assigned to hospitalisations for CPA in each country.

We used SAS 9.4 software for all analyses.

Reporting

We report this study in accordance with the Reporting of Studies Conducted using Observational Routinely Collected Data (RECORD) guidelines.[33]

Ethics approval

Patient consent was not required for this multinational cohort study.

For Denmark: Ethical approval is not required for register-based studies in Denmark.[34] Data use was approved by the Capital Region's responsible institute (P-2019–280) in accordance with the General Data Protection Regulation.

For England: An approval by an ethics committee was not applicable. The use of Hospital Episodes Statistics data was approved by the Health and Social Care Information Centre for the purpose of this study (DARS-NIC-393510-D6H1D-v6.11).

For France: This study was approved by the National Committee for data protection: declaration of conformity to the methodology of reference 05 obtained on 7/08/2018 under the number 2204633 v0. Patient consent was not required, and patient-identifying information was not used in the research as the database was based on pseudonymised data.

For Wales: We did not require National Research Ethics Committee approval to access the data from Wales as the data were anonymized and there was no patient involvement. The Information Governance Review Panel (IGRP) granted approval to access and link the data under project number 0916. Data were linked and analysed within the SAIL Databank secure research environment, and were treated in accordance with the Data Protection Act 2018 and the principles underlying the General Data Protection Regulation.

For Ireland: The confidentiality of the data collected by the Healthcare Pricing Office (HPO) is its highest priority. In fulfilling a request for data, the HPO will supply HIPE data, provided the request does not conflict with our obligations of confidentiality or with those under the Data Protection Acts 1988–2018 and the General Data Protection Regulation.

Data users who request HIPE data directly from the HPO (when data requested is not publicly available) sign a data sharing agreement whereby they agree to only use the data for the purpose it was intended.

Role of the funding source

The funders had no role in the study design, data collection, data analysis, interpretation, or writing of the report.

Results

From 2013 to 2021, among 3,977,439 hospitalisations of infants aged one month to one year in Denmark, England, France, Ireland, and Wales, 6698 (0.17%) were for CPA (Table S2).

From 2013 to 2021, among 12,620,354 hospitalisations of children aged one month to five years in Denmark, England, France, Ireland, and Wales, 13,885 (0.11%) were for CPA (Table S2).

Primary objective: Trends in Child Physical Abuse.

Children as the unit of analysis: data from Denmark, England, France, and Wales

Annual number of children hospitalised for child physical abuse

Among the four European countries included, the pooled number of infants hospitalised for CPA (Fig. 1, Table S2) ranged between 651 and 682 per year from 2013 to 2017. We observed an initial decline in the number of CPA cases in 2018 (N = 610) and then a 5.0% decrease between 2019 (N = 622) and 2020 (N = 589), with a rebound in 2021 (N = 606). We also calculated the

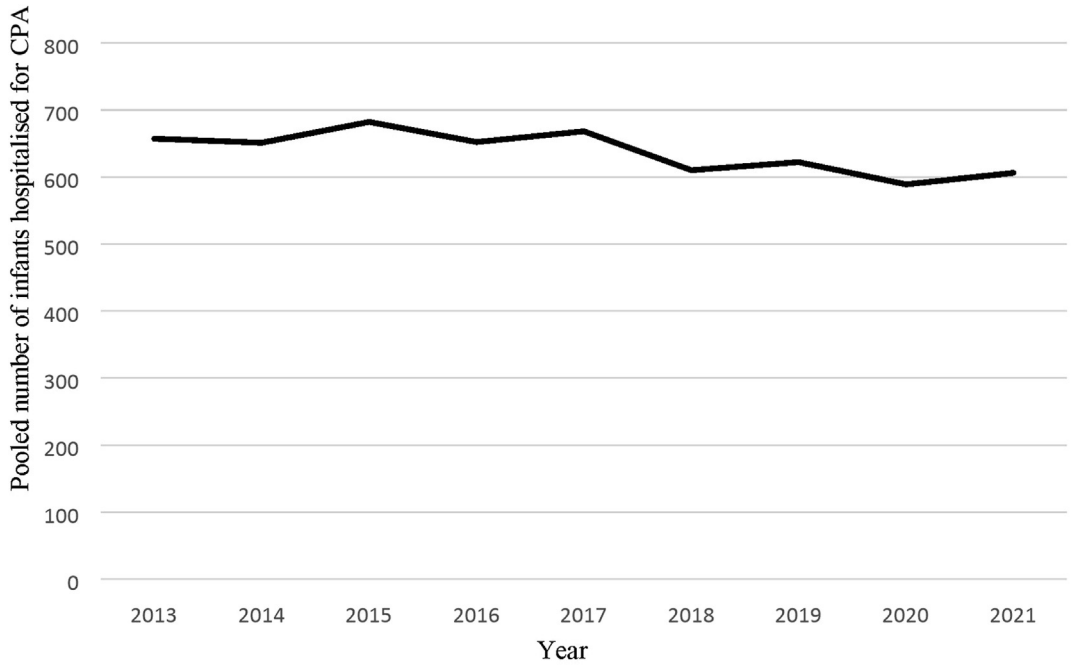

***Fig. 1:* Pooled Number of infants hospitalised for child physical abuse in Denmark, England, France, and Wales, 2013–2021**. CPA, child physical abuse.

annual number of infants hospitalised for CPA by country (Table S3).

For children aged one month to five years, the pooled number of children hospitalised for CPA decreased from a high of 1515 in 2015 to 1170 in 2020, with a 10% decline between 2019 and 2020 and also a rebound in 2021 (Table S2). We also calculated the annual number of children less than five years old hospitalised for CPA by country (Table S4).

Annual incidence rates of children hospitalised for child physical abuse per 100,000 resident children

The pooled incidence rates for infants hospitalised for CPA were around 42/100,000 infants per year (Fig. 2a). The Cochrane–Armitage test indicated that the incidence rates were stable over time ($p = 0.73$), which was confirmed by the time-series analysis ($p = 0.42$).

Average incidence rates per country ranged from 33/100,000 in Wales to 48/100,000 in England (Fig. 2b). Annual incidence rates were generally very similar between countries, with a few exceptions (Fig. 2b, Figure S1). In 2018, there was an increase in Denmark and England and a decrease in France and Wales (Fig. 2b). In 2020, there was an increase in Denmark and Wales and a slight decrease in England and France (Fig. 2b). There were significant differences between France and England in the years 2017, 2018, and 2021, and between Wales and England in 2018 as indicated by non-overlapping confidence intervals (Figure S1).

The pooled incidence rates in children aged between one month and five years were lower than in infants (around 18/100,000 per year). Although incidence rates appeared to decrease slightly after 2015, this trend was not statistically significant (Figure S2). Average incidence rates for children less than five years were highest in England and Wales and lowest in France (Figure S3), with some significant differences in annual incidence rates between countries (Figure S4). Moreover, incidence rates remained stable in England and France over time but fluctuated in Denmark and Wales (Figure S3).

Annual number of children hospitalised for any reason

The pooled number of infants hospitalised for any reason (Table S2, Fig. 3a) ranged between 265,312 and 279,327 per year from 2013 to 2019. We observed a drop of around 30% in the number of infants hospitalised in 2020 (N = 199, 416) and then a rebound in 2021 (N = 257,567).

For children aged between one month and five years, the pooled number of children hospitalised for any reason (Table S2, Figure S5) was around 850,000 per year from 2013 to 2019, with a drop of around 30% in 2020 (N = 573,133) and then a rebound in 2021.

Annual proportion of children hospitalised for child physical abuse among children hospitalised for any reason

The pooled proportion of infants hospitalised for CPA among all hospitalised infants remained stable at approximately 0.25% from 2013 to 2019 (Fig. 3b). In 2020, this proportion increased by 20%–0.30%, followed

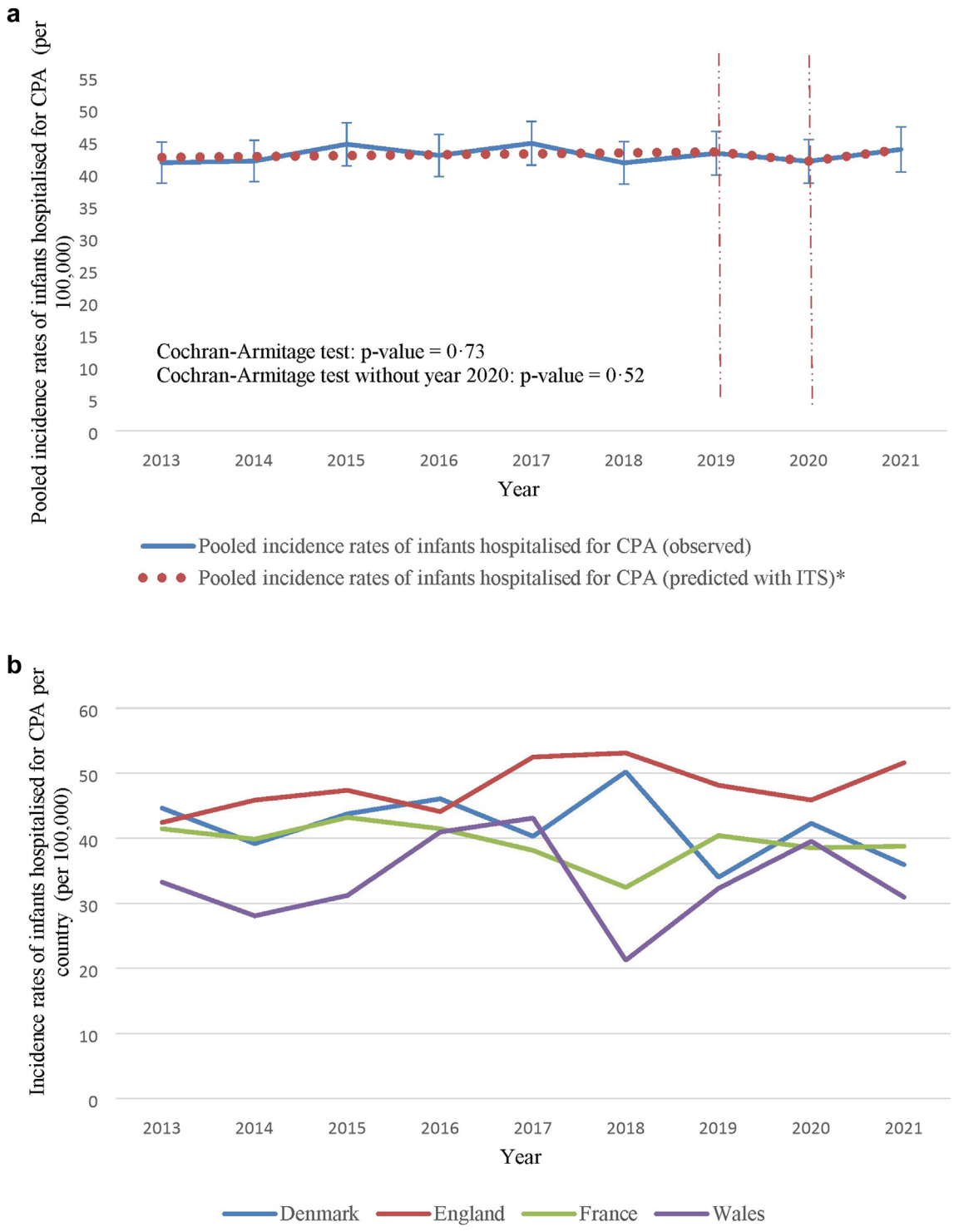

Fig. 2: **Incidence rates of infants hospitalised for child physical abuse per 100,000 infants in Denmark, England, France, and Wales, 2013–2021: a) pooled data; b) per country**. CPA, child physical abuse; ITS, interrupted time-series. Error bars on panel a represent 95% confidence intervals. Cochran–Armitage test on panel a is used to study variations over time. Interrupted time-series analysis on panel a is used to test for a variation in the tendency of changes in relation with the COVID-19 pandemic in 2020. *Interrupted time-series analysis (Panel a): no significant change in 2020 (p = 0.42).

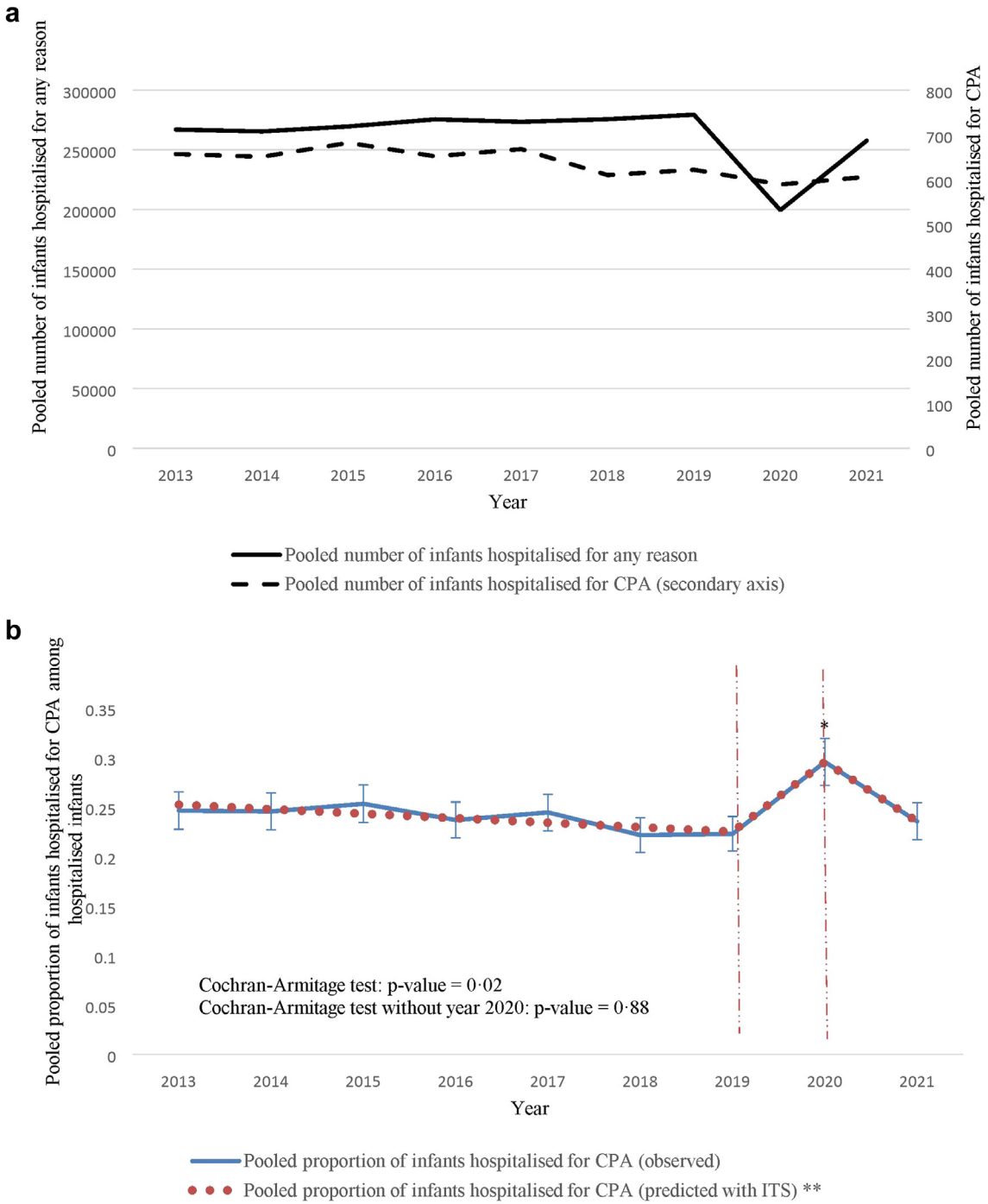

***Fig. 3*: Infants hospitalised in Denmark, England, France, and Wales, 2013–2021: a) Pooled number of infants hospitalised; b) Pooled proportion of infants hospitalised for child physical abuse among all hospitalised infants**. CPA, child physical abuse; ITS, interrupted time-series. Error bars on panel b represent 95% confidence intervals. Cochran–Armitage test on panel b is used to study variations over time. Interrupted time-series analysis on panel b is used to test for a variation in the tendency of changes in relation with the COVID-19 pandemic in 2020. *Significantly different from the rate in 2019, the mean rate during the period 2013–2019 and the median rate during the period 2013–2019 (Chi-squared tests on Panel b). **Interrupted time-series analysis (Panel b): significant change in 2020 ($p < 0.01$).

by a decrease to 0.24% in 2021. The overall increase in the pooled proportion of hospitalisations for CPA over time was significant ($p < 0.01$), but this significance was no longer observed when 2020 was excluded ($p = 0.59$). This result was confirmed by the time-series analysis which showed a significant change in 2020 ($p < 0.01$, Fig. 3b). Furthermore, Pearson Chi-squared testing showed that the pooled proportion in 2020 (0.295% [0.293–0.297]) was significantly higher compared with previous years (0.223% [0.221–0.224] in 2019, 0.238% [0.237–0.240] on average from 2013 to 2019, median of 0.239% [0.238–0.239] from 2013 to 2019, $p < 0.01$ for all, Fig. 3b). This rise in 2020 was observed across all countries (Figure S6) but not in 2021. The Mantel-Haenszel Chi-squared test and Poisson regression indicated that the rise in 2020 remained strong after adjusting for country ($p < 0.01$ for both), with no significant interaction between country and year.

The pooled proportion of children aged one month to five years hospitalised for CPA was lower than for infants (0.16%), however we observed similar trends over time in this age group (Figures S7, S8).

Hospital stays as the unit of analysis: data from Denmark, England, France, Ireland, and Wales

Annual number of hospitalisations for child physical abuse

Among the five European countries, the pooled number of hospitalisations for CPA in infants <1 year ranged between 755 and 785 per year from 2013 to 2017 (Table S2, Fig. 4a). In 2018, CPA hospitalisations decreased (N = 723), followed by a 9.5% decline from 2019 (N = 745) to 2020 (N = 674), and a rebound in 2021 (N = 716).

For children aged between one month and five years, we observed a decrease in the number of CPA hospitalisations from 2015 (N = 1657) to 2020 (N = 1341) with a drop of around 10% between 2019 and 2020 (Table S2, Figure S9) and a rebound in 2021.

Annual number of hospitalisations for any reason

Among infants, the pooled number of hospitalisations for any reason ranged between 455,218 and 478,290 per year from 2013 to 2019 (Table S2, Fig. 4a). We observed a drop of around 30% in the number of hospitalisations in 2020 (N = 321,773) and a rebound in 2021 (N = 394,278).

For children aged between one month and five years, the pooled number of hospitalisations for any reason was around 1,500,000 per year from 2013 to 2019, which dropped by around 30% in 2020 (N = 985,399; Table S2, Figure S9) and rebounded in 2021.

Annual proportion of hospitalisations for child physical abuse among all hospitalisations

Among infants, the pooled proportion of hospitalisations for CPA among all hospitalisations remained stable at approximately 0.16% from 2013 to 2019 (Fig. 4b). There was an increase of 30% in 2020 (pooled proportion of 0.21%) followed by a decrease in 2021 (pooled proportion of 0.18%). The increase in the proportion of hospitalisations for CPA over time was significant ($p < 0.01$) but no longer so when excluding 2020 ($p = 0.59$). This result was confirmed by the time-series analysis where we observed a significant change in 2020 ($p < 0.01$, Fig. 4b). Furthermore, this proportion was significantly higher in 2020 (0.209% [0.208–0.211]) compared with previous years ((0.160% [0.159–0.161] in 2019, 0.163% [0.162–0.164] on average from 2013 to 2019, and a median of 0.162% [0.162–0.162] from 2013 to 2019, $p < 0.01$ for all, Fig. 4b). The increased proportion was observed in all countries in 2020 (Figure S10). The Mantel-Haenszel Chi-squared test and Poisson regression indicated that the increase remained strong after adjusting for country ($p < 0.01$ for both), with no significant interaction between country and year. In addition, on average, the proportion of hospitalisations for CPA in infants was highest in France and lowest in Wales (Figure S10).

The pooled proportion of hospitalisations for CPA in children aged one month to five years was lower than for infants (around 0.11% from 2013 to 2019) but the same trends were observed (Figure S11), including the rise in 2020 in all countries (Figure S12). Moreover, on average, the proportion of hospitalisations for CPA was highest in England and lowest in Ireland (Figure S12).

Secondary objective: distribution of ICD-10 codes used: data from Denmark, England, France, Ireland, and Wales

There were differences in the distribution of ICD-10 codes used to identify hospitalisations for CPA differed in the various countries (Fig. 5). In Denmark and France, 90% of CPA hospitalisations were identified as physical abuse (ICD-10: T74.1). In Wales and England, the most widely used codes were T74.1 and W50 (hit, struck, kicked, twisted, bitten or scratched by another person). In Ireland the most widely used code was W50, followed by Z04.5 (examination and observation following other inflicted injury).

Discussion

Although CPA is associated with significant health, social, and educational consequences, evidence on CPA-related hospitalisations is scarce. In this large-scale multinational study, we applied a standardised approach using nationwide administrative hospital data to compare trends in CPA hospitalisations across five European countries (Denmark, England, France, Ireland, and Wales) over a nine-year period (2013–2021). We analysed over 12 million hospitalisations of children less than five years old in these countries and found that annual incidence rates of infants hospitalised for CPA were largely consistent across countries, whereas greater variation was observed in children aged less than five. Year-on-year trends differed, with incidence rates fluctuating more in some

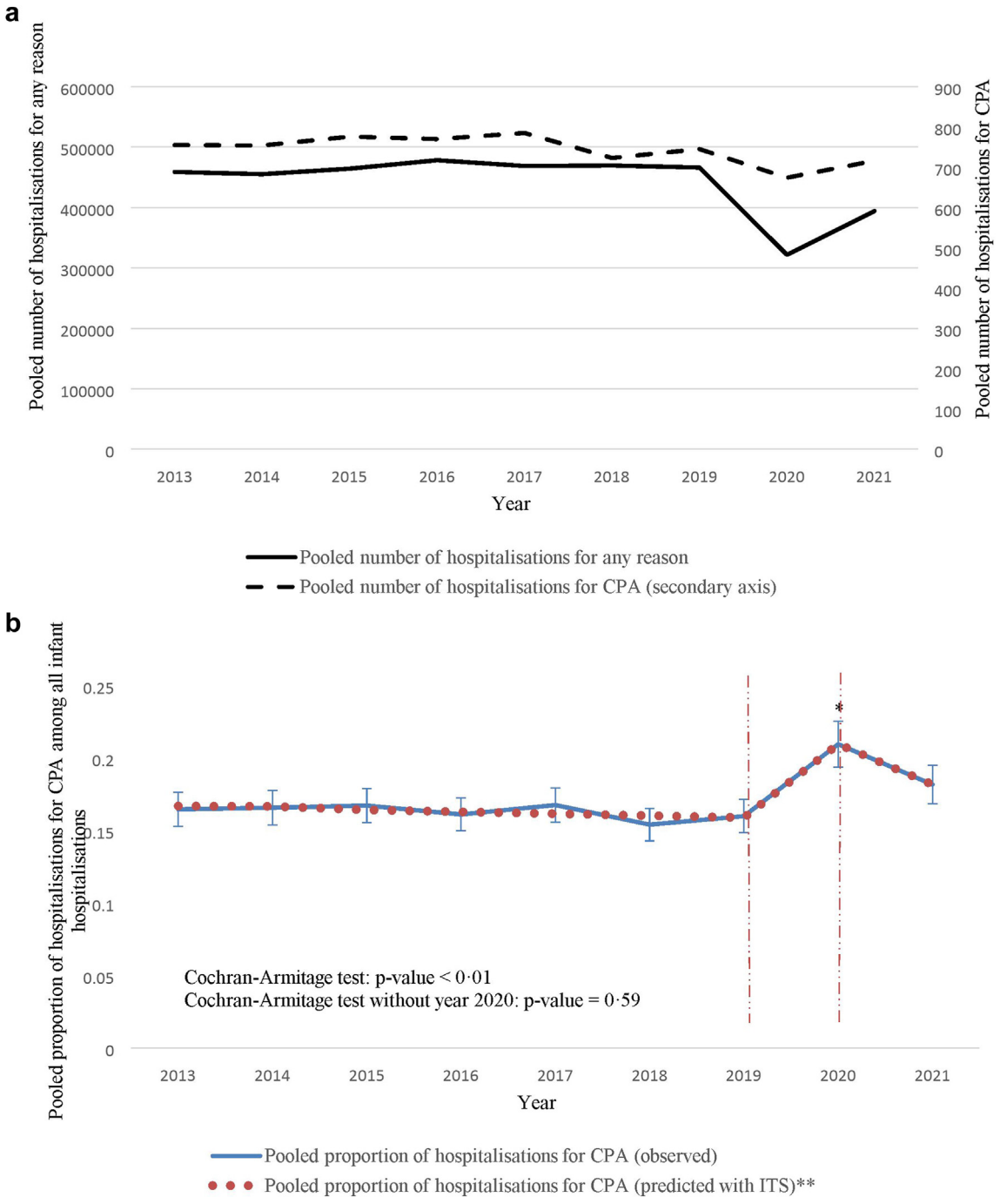

Fig. 4: **Hospitalisations of infants in Denmark, England, France, Ireland, and Wales, 2013–2021: a) Pooled number of hospitalisations; b) Pooled proportion of hospitalisations for child physical abuse among all infant hospitalisations**. CPA, child physical abuse; ITS, interrupted time-series. Error bars on panel b represent 95% confidence intervals. Cochran–Armitage test on panel b is used to study variations over time. Interrupted time-series analysis on panel b is used to test for a variation in the tendency of changes in relation with the COVID-19 pandemic in 2020. *Significantly different from the rate in 2019, the mean rate during the period 2013–2019 and the median rate during the period 2013–2019 (Chi-squared tests on Panel b). **Interrupted time-series analysis (Panel b): significant change in 2020 ($p < 0.01$).

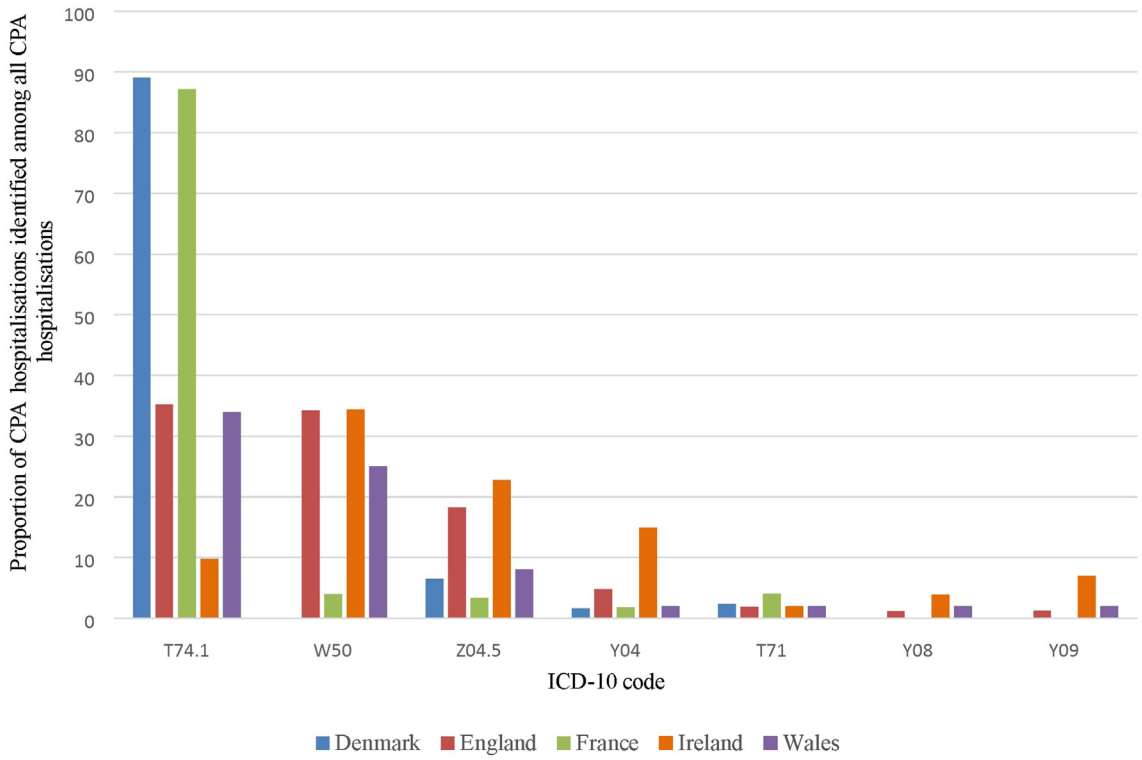

Fig. 5: **Distribution of the most frequent ICD-10 codes used to identify hospitalisations for child physical abuse per country, 2013–2021.** CPA: child physical abuse; ICD-10: 10th edition of the International Classification of Diseases. T74.1: Physical abuse, W50 (not used in Denmark): Hit, struck, kicked, twisted, bitten or scratched by another person, Z04.5: Examination and observation following other inflicted injury, Y08: Assault by other specified means, Y09: Assault by unspecified means, Y04: Assault by bodily force, T71: Asphyxiation.

countries than in others. The pooled incidence rate of infants hospitalised for CPA remained stable over the study period at approximately 42 per 100,000, ranging from 33 to 48 per 100,000 across countries. The pooled proportion of CPA hospitalisations in infants was approximately 0.17%, ranging from 0.06% to 0.23% across countries, despite observed national differences in the distribution of ICD-10 codes used to record CPA. In children less than five years old, the incidence rates and proportions of CPA hospitalisations were lower than in infants, but similar trends were observed.

Over the study period, the average incidence rate of both infants and children less than five years old hospitalised for CPA was highest in England (48/100,000 for infants and 24/100,000 for children less than five years old). Differences in incidence rates may reflect increased awareness of CPA or true differences between countries, but they may also reflect differences in admission thresholds, service organisation, performance targets, or coding practices. The increase in the incidence rate in England could thus reflect improvements in the sensitivity of coding, where the number and accuracy of codes used is incentivised by the 'payment by results' system.[35] However, this system is not in operation in Wales, where the incidence rate also increased. In France, the number of diagnostic codes used was expanded to 1000 in the early 2010s. However, the incidence rate did not increase until 2018. There were marked fluctuations in Denmark and Wales, but given the small numbers of annual CPA hospitalisations in these countries, no firm conclusions can be drawn, and these findings likely reflect random fluctuations over time.

Despite variations between countries, the pooled incidence rates of CPA remained stable over time. It is unclear whether this is due to a failure of policies and interventions to reduce the prevalence of CPA or whether this reflects improved identification of CPA alongside an overall decline in rates. Nevertheless, these findings highlight that CPA is clearly a pressing and ongoing public health issue in Europe. Our findings are not directly comparable with previous studies that compared trends in CPA hospitalisations over time between different countries because of variations in the countries included, the timing, the ages of the children, and the age groups analysed.[21–23] One seminal study published in 2012 compared data from the United States, Manitoba (Canada), New Zealand, Australia, the

United Kingdom, and Sweden between 1979 and 2009 and recorded consistent trends between countries in maltreatment-related injury admissions for high-risk injuries.[21] Our finding that the incidence of CPA in infants is higher than in older children is consistent with previous studies.[10]

The data showed an increase in the proportions of CPA hospitalisations in 2020 in all countries, linked to the COVID-19 pandemic. This is likely attributed to a reduction in overall hospital admissions following pandemic-related lockdowns, while CPA admissions remained stable. These findings are consistent with a recent study examining the impact of the pandemic on assessments for suspected physical abuse in Ireland. The study found that the absolute numbers of children less than 24 months of age who underwent a skeletal survey examination for suspected physical abuse during 2020/2021 were in line with numbers in the preceding 4 years.[36] All types of admissions increased for infants and children aged less than five years after COVID-19 lockdown periods.[37] However, an alternative explanation is that there was a true increase in CPA during 2020; one multi-site study conducted in France reported an actual increase in abusive head trauma during 2020.[38]

We found that the use of ICD-10 codes to identify hospitalisations for CPA differed from one country to another. Denmark and France predominantly used code T74.1 (physical abuse). While in France this is the clinicians' choice as it is possible to use all ICD-10 codes, in Denmark the W50 code (Hit, struck, kicked, twisted, bitten or scratched by another person) is not in use. In Wales and England, both codes T74.1 and W50 were used fairly equally although there was a slight preference for code T74.1 in Wales. In Ireland, W50 was the most widely used, followed by Z04.5 (Examination and observation following other inflicted injury), while T74.1 was used much less than in other countries. This suggests a preference for codes linked to a mechanism of injury and a reluctance to use codes that assign intentionality and culpability, which may partly explain why the proportion of recorded CPA hospitalisations was lower in Ireland than most of the other countries. Similarly, exploration of missed cases of CPA in Wales found that hospital admissions data focuses on documenting the injuries that children present with rather than the presence of abuse.[39] Qualitative studies and training initiatives such as the TICANDAC programme (Training on Child Abuse and Neglect Coding; https://liu.se/en/research/barnafrid/ticandac) may help to shed light on the variation in coding practices between countries and improve consistency in the recording of CPA. Other research groups in the Euro-CAN network have advanced in harmonising child maltreatment definitions, which may improve comparability in future research. Our findings may further support standardising data collection and coding to improve data quality.

A major strength of this study is the inclusion of longitudinal data from multiple European countries on hospitalisations for CPA, a major public health problem that, paradoxically, remains poorly documented.[40] It is the first study we are aware of to compare CPA hospitalisations over time in more than two European countries. It involved a network of experts in child maltreatment data collection and surveillance, collaborating in Working Group 2 of the Euro-CAN COST Action initiative (www.euro-can.org). To identify cases of physical abuse, we used our previously developed validated algorithm.[15] We prioritized specificity over sensitivity since we wanted to determine if it was possible to use a common algorithm to compare temporal trends in hospital admissions for CPA between countries using a standardised approach. Therefore, we know that, whilst not all cases of CPA will have been identified, we can be confident the children that have been identified are highly likely to have suffered physical abuse.

This work is based on data from countries participating in Working Group 2 of COST Action 19,106, including two in the United Kingdom. We are aware that other countries, such as Sweden, have access to similar data, and future studies should attempt to include data from these countries. One limitation was the lack of unique child-level identifiers in Ireland,[41] which prevents us from estimating the incidence rate of children hospitalised for CPA in that country. Legislation introduced by the Irish Government in 2014 (Health Identifiers Act) led to the development of an Individual Health Identifier that will link individual records from different systems to give a complete medical history. When complete, this will enable analysis of discharges at the individual patient level. We were unable to account for the clustering effect of hospitals seeing as data from each country were aggregated nationally. However, we were able to take into account the variability between countries using the Mantel-Haenszel Chi-squared test. Although we used several methods to study trends over time, which gave similar results, we recognise that the analysis would have been more robust using monthly data. However, it was not possible to obtain the data with this time-scale and so we have conducted this study using annual data. Another limitation is that the use of ICD codes alone to identify CPA will inevitably underestimate the burden of abuse.[42] Our findings only represent the tip of the iceberg as a considerable proportion of physically abused children are not brought to hospital despite their injuries, and some do not sustain injuries that require hospital care. In addition, ICD codes are mainly used for administrative and financial purposes rather than epidemiological purposes, and we relied on a core set of ICD-10 codes to identify physical abuse. National coding variations may have led us to underestimate our observations. Because we prioritized specificity over sensitivity,

the algorithm will not have identified cases of abusive head trauma that are coded only as "subdural haematoma". We excluded infants less than one month old due to the difficulty distinguishing between abused infants and those with peri-obstetric lesions or congenital conditions in this age group.[15] Finally, children who died outside the hospital setting were not included, making it impossible to estimate missed CPA-related deaths or variations between countries. Unexpected deaths outside the hospital setting are traditionally handled by the police, and where applicable, forensic pathologists. Consequently, these would be excluded from ICD codes. We were also unable to include data on in-hospital deaths since it was not available for all countries.

A priority for future research is to distinguish genuine differences in the occurrence of hospital admissions for CPA from variations in admission thresholds or coding practices. High quality studies are needed to examine whether policies or interventions affect incidence rates. Our analyses could be extended to other age groups, countries, and types of child maltreatment. Future studies could examine the demographics and injury characteristics of children hospitalised for CPA, including mortality. Linkage to other health and social care data would also allow for the examination of risk factors for abuse and potential underidentification. For example, linking hospital admissions with primary care data has been found to maximise the number of cases of child maltreatment that can be accurately identified in Wales, partly due to the inclusion of child protection codes within primary care data.[39]

If the collection and analysis of CPA hospitalisation data were extended to all European countries and the quality of the information improved, it would be possible to create a European metric for CPA. This would facilitate monitoring and surveillance of CPA, analysis of the impact of events such as pandemics, and measurement of the effectiveness of policies and interventions, all at the national or European level. This evidence could in turn support intergovernmental efforts to prevent and eliminate violence against children. To build this metric, standardising CPA coding practices across European countries would be beneficial. The transition to ICD-11 is a potential opportunity to integrate standardised coding procedures, creating more comparable data for further studies.

Conclusion

This study demonstrates that it is feasible to compare temporal trends in CPA hospitalisations between countries using a standardised approach, which implies that administrative hospital data could be one of several valuable sources of information for surveillance of CPA. We recommend that all European countries make their individual-level data on CPA hospitalisations accessible to researchers to facilitate further comparative and pooled analyses. Data on trends in CPA hospitalisations can be used to inform the public health response to CPA and can assist policymakers in developing and implementing targeted prevention strategies, in line with the United Nations 2030 Sustainable Development Agenda.

Contributors

CQ conceptualised the study. All authors contributed to the design of the study. UN conducted literature searches. CQ and JC accessed, verified and provided the data from France. SW accessed, verified and provided the data from Ireland. CC and RG accessed, verified and provided the data from England. CT-B, MB, and TG-K accessed, verified and provided the data from Denmark. SB, NK, and LEC accessed, verified and provided the data from Wales. JC conducted the statistical analyses and produced the tables and figures. All authors were involved in interpreting the results. CQ and LEC co-wrote the manuscript together. All authors reviewed and edited the manuscript. CQ provided supervisory support to LEC. All authors were responsible for the decision to submit the manuscript.

Data sharing statement

For Denmark: According to the Danish Data Protection Agency and the General Data Protection Regulation, the nationwide data can only be accessible within the protected environment of Statistics Denmark or similar environments. Others with interest in the data need to collaborate with the authors or with other groups authorised to work in these protected environments. No additional related documents will be available.

For England: The authors do not have permission to share patient-level HES data. Source data for England can be accessed by researchers applying to the NHS England (https://digital.nhs.uk/services/hospital-episode-statistics#accessing-data).

For France: The use of the data from the French hospital database by our department was approved by the National Committee for data protection. We are not allowed to transmit these data. PMSI data are available for researchers who meet the criteria for access to these French confidential data (this access is submitted to the approval of the National Committee for data protection) from the national agency for the management of hospitalization (ATIH–Agence technique de l'information sur l'hospitalisation).

Address: Agence technique de l'information sur l'hospitalisation, 117 boulevard Marius Vivier Merle, 69329 Lyon Cedex 03.

For Wales: The data is held in the Secure Anonymised Information Linkage Databank (Data Science Building, Swansea University, Singleton Park, SA28PP) TRE (Trusted Research Environments) and is available through application. The data is restricted and requires review by Information Governance Review Panel (IGRP) who are providing independent guidance and advice on Information Governance policies, procedures and processes for SAIL Databank. All necessary information will be available on the following link: https://saildatabank.com/contact/.

For Ireland: The confidentiality of the data collected by the Healthcare Pricing Office (HPO) is its highest priority. Data users who request HIPE data directly from the HPO (when data requested is not publicly available) sign a data sharing agreement whereby they agree to only use the data for the purpose it was intended.

Declaration of interests

Geoff Debelle has declared payment for expert testimony. He gave independent expert evidence to the courts in UK on infants with physical injury but with no COI in respect of this manuscript. Christian Torp-Pedersen has declared grants or contracts from any entity: Bayer, Grant for randomised study; Novo Nordisk, Grant for epidemiological study. Troels Græsholt-Knudsen has declared support for the present manuscript: COST Action CA 19106, Granted funds for travel in connection with the writing of the article. He has also declared support for attending meetings and/or travel: COST Action CA 19106, Granted funds for travel in connection with the writing of the article. Laura Cowley

has declared support for attending meetings and/or travel: she received support to attend meetings relating to this work from the Euro-CAN COST Action 19106 Network. Catherine Quantin has declared participation on a Data, Safety Monitoring Board or Advisory Board: CSE PAISAGE; External Advisory Board of the HealthData@EU Pilot project.

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The Healthcare Pricing Office is the source of the data used for Ireland data.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.lanepe.2025.101270.

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