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'What about the dads?' Linking fathers and children in administrative data: A systematic scoping review

Irina Lut[1], Katie Harron[1], Pia Hardelid[1], Margaret O'Brien[2] and Jenny Woodman[2]

Abstract

Research has shown that paternal involvement positively impacts on child health and development. We aimed to develop a conceptual model of dimensions of fatherhood, identify and categorise methods used for linking fathers with their children in administrative data, and map these methods onto the dimensions of fatherhood. We carried out a systematic scoping review to create a conceptual framework of paternal involvement and identify studies exploring the impact of paternal exposures on child health and development outcomes using administrative data. We identified four methods that have been used globally to link fathers and children in administrative data based on family or household identifiers using address data, identifiable information about the father on the child's birth registration, health claims data, and Personal Identification Numbers. We did not identify direct measures of paternal involvement but mapping linkage methods to the framework highlighted possible proxies. The addition of paternal National Health Service numbers to birth notifications presents a way forward in the advancement of fatherhood research using administrative data sources.

Keywords

Administrative data, data linkage, paternal involvement, child health

Introduction

The relationship and daily interactions children share with their parents are key elements of child development. Parents may be either biological or social. Social parent is a term used to describe an adult who fulfils a parenting role but is not biologically related to the child, such as a step-parent. Although single-parent families make up 15% of all families in the United Kingdom, the majority of families are still two-parent households, with either married or cohabiting parent figures (Office of National Statistics, 2019).

Father involvement, characterised by the extent to which fathers interact with and ways in which they care and provide for their children, has historically centred around the contribution of human, financial, and social capital, with less focus on the more personal and nurturing components of parenthood (Marsiglio et al., 2000). Early research focused on the negative effects of father absence until the 1970s, when more studies began to explore the potentially positive and direct impact of a father's presence, instead of taking a dichotomous (present vs. absent) view of fatherhood (Lamb, 2000). Fathers are now increasingly spending time with their children and perform their parenting role differently than they did before the 1980s (Lamb, 2000). Modern fatherhood has been influenced by a number of factors including increased employment of women as well as the diversity of new family forms and residence patterns (Marsiglio et al., 2000), with up to 2.4 million children in Great Britain living apart from one of their biological parents in 2017–18 (Department for Work and Pensions, 2020).

Research has shown that healthy interactions with fathers positively impact on child health, improving children's cognitive and behavioural outcomes like educational attainment (Bronte-Tinkew et al., 2008) or antisocial behaviour (Sarkadi et al., 2008), and moulding socialisation behaviours (Rosenberg and Wilcox, 2006). Cohort studies have traditionally been used to explore the association between father

[1]UCL Great Ormond Street Institute of Child Health, London, UK
[2]Thomas Coram Research Unit (TCRU), Social Research Institute, UCL Institute of Education, London, UK

Corresponding author:
Irina Lut, University College London Institute of Child Health, 30 Guildford Street, London WC1N 1EH, UK.
Email: i.lut@ucl.ac.uk

involvement and child outcomes. A systematic review of 24 longitudinal studies from the 1990s and early 2000s found that father engagement is associated with positive social, behavioural, and psychological outcomes independent of family socioeconomic background (Sarkadi et al., 2008). A more recent systematic review of 86 studies from 2010 to 2019 reported that positive paternal involvement was related to lower externalizing behaviours and greater cognitive ability while lower involvement was related to greater peer aggression (Diniz et al., 2021). Most studies examined the consequences of father involvement on children's socio-emotional and behavioural outcomes and focused on aspects related to paternal engagement rather than availability or responsibility (Diniz et al., 2021). Interview data from a large nationally representative cohort study of children born in 2001 in the United States and video-recorded observational data of fathers interacting with their children in the home, showed that fathers' engagement in learning activities and caregiving is associated with up to a 7% reduction in the odds of negative cognitive outcomes (e.g. delay in reaching key milestones like babbling or exploring objects with purpose) (Bronte-Tinkew et al., 2008; Sethna et al., 2017). Father engagement was also associated with higher cognitive functioning scores (based on Bayley Scale of Infant Development Second Edition) in young children up to the age of 2 years (Sethna et al., 2017). Findings from interview data in the UK Millennium Cohort Study showed that two measures of father involvement (positive parenting beliefs and frequency of creative play) were associated with lower risk of behaviour problems in children under the age of 7 (Kroll et al., 2016). Researchers using data from the Avon Longitudinal Study of Parents and Children in the United Kingdom created an involvement scale based on questions around direct care, sharing of household tasks, attitudes towards parenting, relationship with the child, and paternal feelings using factor analysis (Opondo et al., 2016; Opondo et al., 2017). They found strong evidence that emotional response to the infant is associated with a 13% reduction in the odds of children reporting depressive symptoms (Opondo et al., 2016; Opondo et al., 2017).

Although the evidence base focusing on the impact of fathers on child health and development is progressing, key areas that require further research include the father's role in preconception health and how this impacts the child's health later in child and adulthood (Kortsmit et al., 2020; Kotelchuck and Lu, 2017), differentiation of paternal involvement across groups of fathers (e.g. residential vs. non-residential) (Cabrera et al., 2014) and the lack of ethnic and socioeconomic diversity among fathers that are captured in the evidence base (Diniz et al., 2021).

Studies of fatherhood typically rely on primary data collection, using interview or survey methods which involve participant engagement. These are vulnerable to selection or attrition biases, which can be particularly high among fathers because of social and structural barriers including norms around masculinity, feelings of exclusion, and clashes with employment responsibilities (Cabrera et al., 2018; Leach et al., 2019; Macfadyen et al., 2011). Fathers are not only underrepresented in research; lower rates of paternal participation and retention are also found in interventions or services aiming to improve parental skills and engagement with children (Bayley et al., 2009; Panter-Brick et al., 2014). Furthermore, studies that only ask mothers about father involvement can introduce recall or reporting biases (Charles et al., 2018). A scoping review of the ways in which large-scale cross-sectional and longitudinal datasets in the United Kingdom identify and collect information about fathers concluded that the existing questionnaires do not allow for sufficient differentiation between fathers, mothers, and different categories of parents (Goldman and Burgess, 2017). The authors recommended that future questionnaire design for national surveys and cohort studies includes more nuanced parenthood questions that are asked of both men and women.

To mitigate some of these limitations, cohort studies have begun linking self-report cohort data to the participants' administrative records. Doing so can supplement survey data with new variables without needing to involve participants in further data collection. For example, data from National Health Service (NHS) Digital, which acts as the information centre and data provider for the NHS of England has now been linked to the Next Steps Study, a longitudinal study following the lives of young people born in England in 1989–90, with plans for further linkage with older cohorts underway (Centre for Longitudinal Studies, 2020). These links, however, may be limited by ethical challenges, particularly the need for additional consent. Therefore, in this review, we focus exclusively on the use of administrative data.

Administrative data, collected when members of a society interact with public services, provide researchers with an alternative to more traditional data collection methods when high costs and poor participation or loss to follow-up could become a problem (Jutte et al., 2011). Large national datasets provide reliable information on vulnerable populations and people who may otherwise have been excluded from, or chosen not to engage with, research (Connelly et al., 2016). Using administrative data allows for substantial coverage of the study population in a shorter time frame and can reduce selection or non-response biases compared to primary data collection (Olsen, 2011). The availability of a greater number of observations in administrative data provides greater statistical power and makes it easier to follow study participants over time since they do not need to engage with study team members (Jutte et al., 2011).

There are some key challenges of using administrative data in research (Connelly et al., 2016; Playford et al., 2016). These data are not collected for research purposes and therefore not tailored to answering a particular research question or include all relevant variables required for a research study. The information available in administrative datasets relates to service

provision and use; thus administrative data commonly only capture basic demographic information and social contacts. In the context of fatherhood research, researchers may need to make use of existing variables as proxies for measures of paternal involvement. The use of administrative data for research requires the information provided to be reliable but due to the nature of its collection, administrative data sources are likely to have data quality issues (Hand, 2018). Data linkage, the process of combining data from multiple sources, can be used to mitigate some of these weaknesses by including more variables and opportunities for validation. This provides the potential for researchers to use administrative data to investigate relationships between parents and children's health at the population level, with minimal selection bias.

A wide range of administrative data are already being linked to understand how the health and well-being of mothers and children are associated (Harron et al., 2016), e.g., via linkage of maternal and baby hospital records (Harron et al., 2016; Hilder et al., 2007). Researchers using these methods have found that babies born to mothers with pre-pregnancy psychosocial risk factors tended to have lower birthweight compared to those born to mothers without these risk factors (Harron et al., 2021), and that induction of labour at 40 weeks was associated with a third of the risk of in-hospital perinatal death compared to expectant management (Knight et al., 2017).

Linkage of children to fathers cannot rely on the same methods as for mothers and children because there is no record of a birth or of fatherhood in a man's hospital records, at least in the United Kingdom. This scoping review critically describes available methods for linking fathers with their children in administrative data, and the next steps to accelerate the evidence are based on the impact of fathers on child health using administrative data (Poole et al., 2016).

We conducted a scoping review to (1) develop a conceptual model of dimensions of paternal involvement used within fatherhood research, (2) identify and categorise the methods used for linking fathers with their children in administrative health data, and (3) map these methods onto the dimensions of fatherhood to determine whether measures of paternal involvement can exist in administrative data. This will identify future opportunities for research into the impact of fathers on child health using administrative data and steps required to make paternal-child linkage possible in England.

Methods

We carried out a systematic scoping review to create a conceptual framework of paternal involvement and identify studies of paternal impacts on child health using administrative data. We focused on breadth over depth (Arksey and O'Malley, 2005; Rumrill et al., 2010), until reaching conceptual saturation (Thomas and Harden, 2008).

Conceptual framework development

As scholars agree that no one theory comprehensively captures all dimensions of fathers' involvement in their children's lives (Cabrera et al., 2007; Palkovitz, 2019), we developed a framework of social fathering by integrating the key components from relevant theoretical models and empirical studies. We conducted a literature review using a snowballing technique to identify key scholars and literature in the field. We then incorporated key dimensions of fatherhood relevant to child health and well-being (i.e. those theorised and/or measured in empirical studies) into a conceptual framework.

Identifying father–child linkage studies

We next aimed to identify studies of fatherhood that used linked administrative data and to determine the methods used for linking fathers' records with those of their children.

Search strategy

We searched PubMed, Scopus, and Google/Google Scholar for English language publications from 2000 to 2020 using MeSH and free-text terms for 'administrative data' or 'linked data' and 'father'. A full list of search concepts and terms can be found in Supplemental Material 1. In addition to web searches, we also asked key experts from the International Population Data Linkage Network (Jones and Ford, 2018) if they were aware of any relevant work we may have missed.

Inclusion criteria

The exposures of interest were any demographic, health, or other characteristics of fathers during their offspring's childhood or prior to birth (e.g. paternal age, mental health, or chronic illness diagnoses) captured within administrative data. We included studies if outcomes were related to child health and development (e.g. educational attainment, behavioural outcomes, hospital admissions) measured before 18 years of age.

Screening

One reviewer (IL) screened all results at both title/abstract and full text phases, with a second reviewer (JW) checking 10% of retrieved papers. Both reviewers agreed on all included studies. Studies with any paternal exposures measured in administrative data were included unless the information on fathers came from the child's records rather than from a linked paternal record. Studies were excluded if they were primarily based on data from a cohort study that was linked with administrative data because we wanted to focus

on what administrative data alone could tell us about the impact of paternal exposures on child health.

Data extraction

For each included study, we extracted key information on exposures and outcomes, the time frame and setting, and the specific methods for data linkage including what data items were used for linkage (e.g. personal identification numbers [PINs] or other identifiers, alone, or in combination) and in what datasets these were found. We categorised studies into groups based on data types and linkage methods. Key characteristics of each study can be found in Supplemental Material 2.

Mapping father–child linkages onto dimensions of father involvement

For each group of linkage methods, we identified how the type of information on which the linkage is based may be used as a proxy for each of the three dimensions of fatherhood defined in our conceptual model.

Results

Conceptual framework: dimensions of fatherhood

Our framework is presented in Figure 1. The first column on the left represents structural, family, and individual influences on fathering as conceptualised by Cabrera et al. (2007), which act as either direct or indirect antecedents to the dimensions of fatherhood (Cabrera et al., 2000), impacting the variation in level and type of father involvement. These are presented in addition to the factors that Lamb and colleagues acknowledge as affecting the relative involvement of fathers (e.g. motivation, skills, support) (Lamb et al., 1987). Whether the father and child live together is a potentially key influence in all dimensions of paternal involvement. Proximity to the child could create more opportunities for involvement. However, patterns of non-resident father contact are not homogeneous, and living in different households does not automatically preclude paternal involvement in any of the three dimensions (Cheadle et al., 2010).

In the centre are the three dimensions of father involvement which form the core of our framework: Engagement, Availability, and Responsibility, based on an influential model developed by Lamb, Pleck, Charnov, and Levine in 1985 (Lamb et al., 1985; Lamb et al., 1987). Lamb and colleagues initially defined the first dimension of father involvement as 'interaction', but later used the term 'engagement' as in our model; these terms are understood to be interchangeable. Interaction was defined as any direct contact with the child such as reading to or playing with the child, or caregiving (Lamb et al., 1985). Supervision of children and disciplining are other elements of this dimension, which also play a role in the safety and appropriate socialisation of children. Building on Lamb's initial model, the quality of the interaction between father and child can also impact on the father's level of engagement. So here, the 'Engagement' dimension includes direct affective and cognitive involvement by the father, also emphasised by others as crucial to the measurement of fathering by Palkovitz (Palkovitz, 2019).

The concept of availability refers to the father being accessible to the child for potential interaction, regardless of whether an interaction actually occurs (Lamb et al., 1985). For example, a father is 'available' if he is at home doing a task while the child is in the next room. In addition to the father's physical presence, we have expanded the 'Availability' dimension to include other elements emphasised by other scholars. The first is emotional availability drawing from Krampe's concept of a father's presence felt within the child, which signifies his psychological nearness and accessibility (Krampe, 2009). The second is the quality of the father–child relationship, which Palkovitz has argued is of central importance to the ways in which fathers and children influence each other's lived experiences and trajectories (Palkovitz, 2019). The third is social capital, which does not involve the potential for interaction between the father and child directly but between the child and adults other than the father (Turley et al., 2017). By making his networks and social capital available to his child, the father is providing future benefits towards the child's development.

Responsibility refers to a father's participation in activities related to monitoring, organising, and decision-making that ensure the child's well-being is taken care of (e.g. arranging medical or education appointments) (Lamb et al., 1985). The 'Responsibility' dimension captures these activities, even if they are done without everyone in the family being aware. Similarly, making plans like ensuring childcare or worrying when the child is sick falls into the 'Responsibility' dimension of fatherhood. Economic provisioning has been theorised as one of the most important aspects of fatherhood and paternal involvement, in line with the historical view of fathers as breadwinners (Marsiglio et al., 2000). One of the most evident and measurable aspects of the 'Responsibility' dimension is financial capital, important for the provision of material resources such as food, shelter, goods, and services (including education) (Pleck, 2007). There has been some debate among scholars about whether economic provisioning should fall under this domain or act as a separate dimension but here we include it as part of 'Responsibility'.

The two columns to the right of the dimensions describe what we know about the associations between the three dimensions of father involvement and child outcomes from empirical evidence, organised by 'mechanisms' that

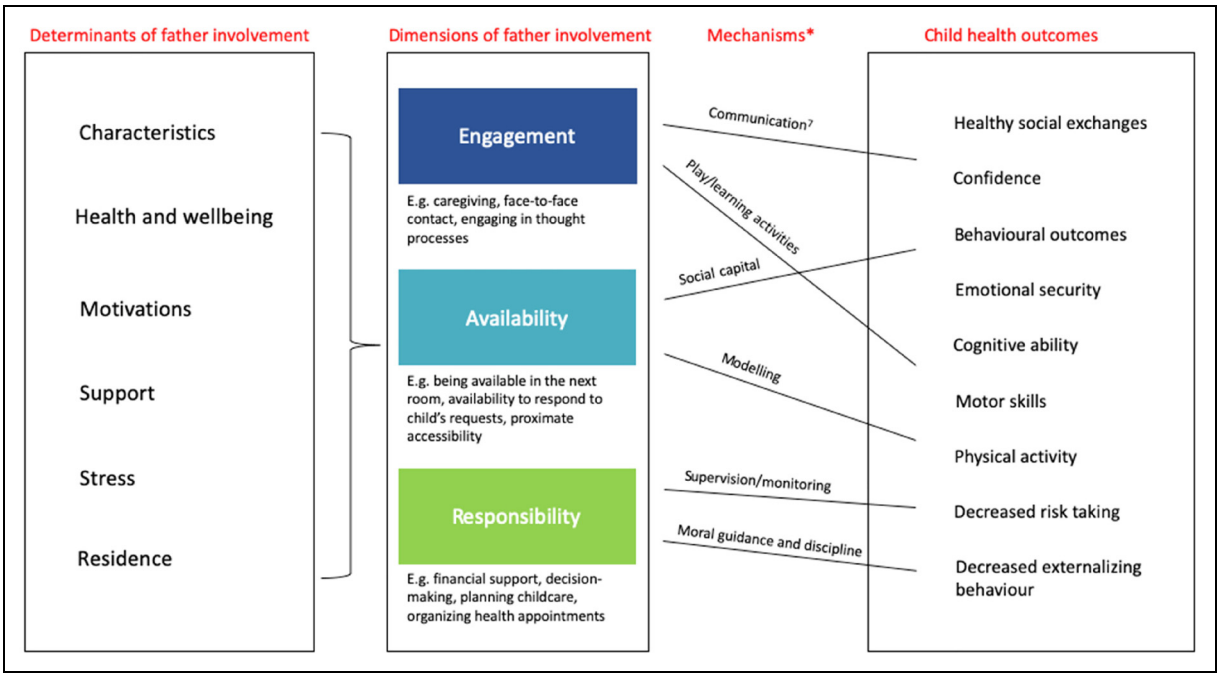

Figure 1. Dimensions of father involvement framework.
*Solid lines indicate mechanisms that have been evidenced in the literature. Note that the examples of determinants in column 1, mechanisms in column 3 and health outcomes in column 4 are illustrative rather than exhaustive

represent how acts of fathering influence specific child outcomes, by how they fit into each dimension.

Two important elements that are likely to determine the influence of fathers on the health, well-being, and development of their children are not captured in our model: a temporal dimension taking into account changing influences, relationships, and behaviours over time and the bidirectional nature of relationships which may affect how fathers and children interact, and how they both experience their interactions (Cabrera et al., 2014).

Studies linking fathers and children in administrative data

A total of 77 studies were included (Figure 2). The principal reasons for exclusion at the full-text phase were outcomes

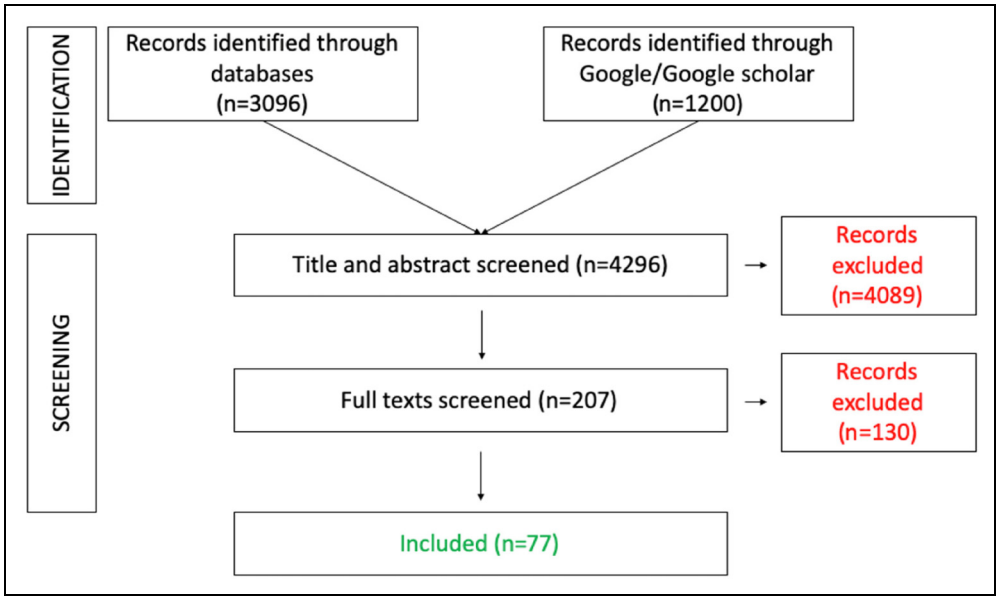

Figure 2. Prisma flow diagram.

Table 1. Linkage methods across different jurisdictions.

Method	Description	Examples in research studies
Group 1: Household or family identifiers Unique identifiers created based on address information and used to link people registered at the **same address** for the purposes of a specific analysis.	In the Secure Anonymous Information Linkage (SAIL) databank in Wales, residential Anonymous Linking Fields (RALFs) are produced for every household based on Local Super Output Area (LSOA) data, and individual ALFs are embedded within this framework (Rodgers et al., 2009). Individual health and social care data can be linked using unique ALFs or a person's relation to other individuals within the same household, who are likely to represent members of the family unit can be identified. Each child is assigned a RALF for each address during the study (Paranjothy et al., 2018).	Paranjothy et al. (2018) found that living with a household member who had a mental health condition or alcohol-related hospital admission was associated with increased risks of emergency hospital admissions in children for all causes (HR 1.17; 95% CI: 1.16–1.19) and certain types of emergency admissions (injuries, external causes, and victimisation) respectively. The authors did not distinguish between maternal and paternal exposures.
	For families living at the same address in London, England, GP, and secondary care (reported directly to general practice) linkage of records for children and adults who living at the same address and registered at the same GP service was used to identify fathers (Dreyer et al., 2018). Fathers were classified as male adults aged 18–55 years, living at the same address as a child under 18 years.	Dreyer et al. (2018) found that after controlling for child and parental characteristics, parental healthcare utilisation was associated with increased child healthcare utilisation across primary and secondary healthcare services: GP (RR = 1.07, 95% CI: 1.06–1.08) emergency (aOR = 1.27, 95% CI: 1.12–1.44) inpatient (aOR = 1.43, 95% CI: 1.06–1.93) and outpatient (aOR = 1.08, 95% CI: 1.01–1.15). The authors did not distinguish between maternal and paternal exposures.
	In the United States, the 1997–1998 Thomson MedStat MarketScan databases hold standardized, detailed, and enrolee-specific clinical utilization information from the medical claims of approximately 45 large employers and health plans. Parents and their children were linked together by a common family identification number.	Logan et al. (2008) found that children whose fathers were diagnosed with adjustment reaction, back pain, and migraines were more likely to have an ambulatory care sensitive (ACS) emergency visit (aOR = 1.22, 95% CI: 1.08–1.37; aOR = 1.13, 95% CI: 1.04–1.24 and aOR = 1.29, 95% CI: 1.06–1.56, respectively) and children whose fathers were diagnosed with depression were more likely to have least one ACS hospitalisation (aOR = 1.37, 95% CI: 10.3–1.83). Paternal depression with pain-related diagnoses, in the absence of maternal mental health or pain-related diagnoses also increased the odds of a child having an ACS hospitalisation (aOR = 2.12, 95% CI: 1.21–3.71) (Logan et al., 2008).

(continued)

Table 1. Continued

Method	Description	Examples in research studies
Group 2: Paternal identifiable information or healthcare number on civil **birth registrations**	In the state of Western Australia (WA), a population-level data linkage system brings together a range of health data sources through probabilistic matching of names and other identifiers (Holman et al., 1999; Holman et al., 2008). Linkage to fathers is done by using paternal identifiers recorded on birth certificates, with other datasets (e.g. marriage records) within WADLS then used to verify the identity of the father.	Bell and colleagues have carried out several studies using this linkage method in WA. One study shows that paternal chronic illness was not associated with increased odds of developmental vulnerability in children on any Australian Early Development Census (AEDC) domain (Bell et al., 2019b). A second study showed that children had significantly increased odds of developmental vulnerability on all five AEDC domains if they had a convicted father, or two convicted parents, compared to parents with neither a community order nor incarceration (Bell, 2018). A third study showed that children of fathers with psychiatric disorders had increased odds of being vulnerable/at-risk on all AEDC domains (38–50% increase) (Bell et al., 2019a).
	In New South Wales, researchers used probabilistic linkage methods to match individuals across different datasets relying on the identifying information provided on individuals by each data custodian. The minimum variables used for matching to identify fathers include name, date of birth, residential address, and sex.	Whitten and colleagues showed that children's rate of emergency department presentation for any reason (aHR* = 1.44, 95% CI: 1.41–1.48) and rates of child ED presentation for physical injury (aHR = 1.7, 95% CI: 1.65–1.75) were higher if fathers had a history of criminal offending (Whitten et al., 2019a). They also reported that paternal offending had the strongest association with children's persisting difficulties, particularly conduct difficulties (aOR = 2.63, 95% CI: 2–3.46) (Whitten et al., 2019b). Tzoumakis and colleagues showed that paternal offending was associated with conduct problems in children (aOR = 1.81, 95% CI: 1.64–2.01) (Tzoumakis et al., 2019) and number of offenses were significantly associated with offspring aggression at age 5 years (Tzoumakis et al., 2017). Dean and colleagues found that children were more likely to experience aggressive behaviour (OR = 1.98, 95% CI: 1.81–2.17), hyperactive and inattentive behaviour (OR = 1.81, 95% CI: 1.66–1.97), and anxious and fearful behaviour (OR = 1.54, 95% CI: 1.4–1.68) if fathers had a history of any mental disorder (Dean et al., 2018). Laurens and colleagues found that paternal offending was significantly associated with each domain of the AEDC (aORs ranging between 1.58 and 2 across domains) (Laurens, 2017). *A hazard ratio (HR) refers to the relative risk of hospital presentation based on rates in exposed and unexposed groups.
	In British Columbia, claims data can be linked using unique personal health card numbers that are assigned to each resident. Parents can then be linked to their offspring using the birth registry and registration file databases because parents'	Lu and colleagues found that the mean birth weight and gestational age of babies whose fathers had multiple sclerosis (MS) were similar to those of babies whose fathers did not have MS ($p > 0.6$). Neither MS disease duration nor level of disability

(continued)

Table 1. Continued

Method	Description	Examples in research studies
	personal health numbers must be provided when registering a child with BC's Vital Statistics Agency. This can also be used to link to other health registers, e.g., the BC Multiple Sclerosis database.	was significantly associated with either outcome ($p \geq 0.2$) (Lu et al., 2014). Razaz and colleagues carried out several studies using this linkage method in BC. The first study showed that children had a higher rate of psychiatric disorders if a parent had MS compared to not having MS (aHR = 1.34; 95% CI: 1.03–1.74) or if a parent had peripartum depression compared to not having peripartum depression (aHR = 1.87; 95% CI: 1.3–2.55) (Razaz et al., 2016). Data for both mothers and fathers were available, but the authors did not present findings by paternal MS only. The second study showed that paternal MS and paternal mental health morbidity were not associated with child mood or anxiety disorders (Razaz, 2016). The third study showed that there was no association between having a chronically ill father affected with MS and the odds of vulnerability on one or more domains of the Early Development Instrument, although authors acknowledge the study may have been underpowered (Razaz et al., 2015).
Group 3: Health claims data	In Taiwan, the National Health Insurance Research Database (NHIRD) holds population level data on for all residents. Family members can be identified through information on consanguineous relations based on claims data (Hsieh et al., 2019). NHIRD can further be linked to a range of other public surveys, disease registries and social reporting system data via personal identification numbers (Lin et al., 2018).	Lin and colleagues found that infants whose fathers were diagnosed with schizophrenia were more likely to be born low birth weight than those whose fathers were not (aOR = 1.58; 95% CI: 1.1–2.52) following adjustment for infant's age, parity, paternal age and highest educational level, gestational age, mothers' marital status, and family monthly income (Lin et al., 2009).
	In Catalonia, The Central Registry of Insured Persons (RCA) provided the identification of CatSalut insurers and the linkage between children and their health cardholder (HCH). Only a legal guardian of the children can be their HCH which, in the vast majority of cases, will be a parent.	Oliver-Parra and colleagues showed that boys and girls whose fathers had a mental disorder (MD) were both more likely to have MD compared to children whose fathers didn't have MD (aOR = 1.66, 95%CI: 1.61–1.7 and aOR = 1.72, 95% CI: 1.66–1.77, respectively).
Group 4: **PINs** (Personal Identification Numbers)	In Norway, Sweden, Denmark, and Finland, each citizen or long-term resident is allocated a personal identification number. Parental PINs are found on birth records. We consider this a different method to that described for Group 2 because PINs in these four countries are referenced on all routinely collected data and facilitates linkage of data across a number of registers (health and non-health).	59 included studies used this method. A range of other exposures were explored; overall studies reported mixed results regarding significant associations between paternal exposures and child outcomes. More information on findings can be found in Supplemental Material 2.

being measured in adult offspring, studies not using administrative data or lack of paternal linkage.

The most commonly studied paternal exposures were chronic illness (including mental health or psychiatric disorders, multiple sclerosis, and cancer) ($n = 31$, 40%), sociodemographic information (SES or immigration status) ($n = 10$, 13%), age ($n = 6$, 8%), paternal birth outcomes (birthweight or preterm delivery) ($n = 8$, 10%), and paternal offending or criminal convictions ($n = 7$, 9%).

The range of child health and development outcomes was broader than that of paternal exposures. Studies largely focused on physical health outcomes such as body mass index, congenital anomalies, asthma, cancers, multiple sclerosis, hospitalisations, and mortality ($n = 25$, 32%), and birth outcomes such as preterm birth, birthweight, and stillbirth ($n = 22$, 29%). Nearly one in five studies ($n = 14$, 18%) looked at developmental outcomes such as grades in school, autism spectrum disorders or domains of the Australian Early Development Census, and mental health outcomes such as psychiatric diagnoses, anxiety, or mood disorders ($n = 14$, 18%). A complete description of all included studies can be found in online Supplemental Material 2.

Linkage methods

We identified four methods for linking fathers with their children in administrative data. The majority of studies ($n = 59$, 77%), from Denmark, Sweden, Finland, and Norway used linkage methods based on PINs, held across all of each country's national population registers. The remaining studies were based on linkages made with address information, information found on birth registrations, or health claims. Two studies from the province of Manitoba, Canada, and the United Kingdom that used Group 1 linkage methods were excluded because parents and children were linked but the outcome referred to the parents or the father–child linkage took place but maternal and paternal exposures were grouped together (Bolton et al., 2013; Davé et al., 2010; Roos and Nicol, 1999). Table 1 describes all identified linkage methods and key findings from the studies that were included in each group. The examples for Groups 1–3 are comprehensive of studies included in those groups. Key information (including a summary of findings) regarding Group 4 studies can be found in Supplementary Material 2.

Identifying dimensions of fatherhood in administrative data

Based on the 77 included studies, we aimed to identify measures of any dimension of paternal involvement in linked administrative data of fathers and children. For example, one of the included studies in our scoping review explored the impact of gender equality of shared parental leave on mental ill health, arguing that the parents' division of parental leave represents an early indicator for caring duties (Norström et al., 2012).

For Table 2, we focussed specifically on how the data items that were used for carrying out the father–child linkages, and the sources of these data items facilitate or hinder the measurement of the three dimensions of fatherhood.

Discussion

Main findings

This is the first scoping review to identify linkage methods for father–child pairs within administrative data and map them onto dimensions of paternal involvement. We identified 77 studies carried out in high-income countries which quantified the association between paternal exposures and child health and development outcomes, using linked administrative data on fathers and their children. We analysed the linkage methods used in these included studies, identifying four key groups based on: family or household identifiers using address data, identifiable information about the father on the child's birth registration, health claims data, and PINs. Using PINs is the only method that can capture all fathers (biological and social, based on address information).

The linkage methods differ in the types of fathers that they capture (e.g. resident vs. non-resident) but are similar in how they can act as proxies for measures of paternal involvement.

Strengths and weaknesses

We have developed an updated fatherhood framework that integrates elements from previous, less comprehensive models. We classified the key methods for linking fathers and children in administrative data and presented the broad range of paternal exposures and child outcomes that have been studied using administrative data. Importantly, we mapped what we can learn from these linkages to the dimensions of fatherhood.

There are some limitations to consider. The use of linkage methods as proxies for paternal involvement is precarious, with significant assumptions being made. The authors alone judged whether each linkage method could act as a proxy for the dimensions of paternal involvement; we did not carry out public and patient involvement on this question. Seven fathers belonging to a parents' group at University College London provided feedback on the paternal involvement framework but did not respond when asked about their views regarding the acceptability and value of linking paternal and child records in administrative data, and the feasibility of a proposed linkage method in

Table 2. Which dimensions of fatherhood can administrative data address?

Linkage methods	Dimensions	Comments
Group 1: Household or family identifier (address)	Engagement ✓ Availability ✓ Responsibility ✓	Co-residence may be used as a proxy for all dimensions of paternal involvement. However, a limitation of this method is the need for assumptions about: (a) the family and household members (the man performing the principal fathering role may still be the non-residential biological father, and we cannot distinguish between fathers and other men in the right age-range in the household) and (b) the frequency and quality of interactions taking place within the household. This method also limits the exposure period to the duration of co-residence.
Group 2: Birth registrations	Engagement Availability ✓ Responsibility ✓	Presence of paternal information on birth certificates could be considered as paternal acknowledgement of the child and investment in their health and well-being. This method allows for a longer follow-up time but no measure of continued involvement throughout childhood.
Group 3: Health claims	Engagement Availability Responsibility ✓	Linkage using health (insurance) claims information only captures named fathers. Naming a child as dependent on an insurance plan indicates provisioning.
Group 4: PINs	Engagement ✓ Availability ✓ Responsibility ✓	Linkage using PINs captures both biological and social fathers. This method may be used as a proxy for all dimensions based on co-residence/distance of residence.

PIN: Personal Identification Number.

England. We believe this was largely due to the review being carried out during the global COVID pandemic and we aim to plan future patient and public involvement sessions as we take our recommendations forward. We also limited studies to English-language; we may therefore have missed studies that would have otherwise fit our inclusion criteria around paternal exposures and child outcomes in administrative data, possibly resulting in an under ascertainment of studies from Nordic countries. Finally, studies using administrative data sources often provide limited detail about the methods used to carry out linkages; therefore, additional linkage methods not captured in our analysis may exist.

Interpretation

The most useful method for studying the impact of paternal involvement, or indeed any paternal exposure on child health within administrative health data, would be to use a PIN system for identifying child–father pairs. This method allows the identification of biological and social fathers who are resident and non-resident with their child(ren).

Many countries, including the United Kingdom, do not currently have a PIN system. One way to move closer to this would be to combine linkage methods based on birth registration and household identifiers (Groups 1 and 2 in Table 1). Father–child linkage within English administrative health records could be facilitated by adding the father's NHS number to the birth registration for the child as is currently done for mothers, particularly in situations where the child is jointly registered by both parents. This linkage could then be supplemented with household links, to give an idea of paternal co-residency with children at various points through childhood. In settings where linkage methods rely on the father's identifiable information (Group 2, Table 1), there is also potential to link to a wide range of external data sources that provide information not otherwise found in health data (e.g. on social care, household income, parental leave) and continue following up the father over time, which may provide better direct measures for paternal involvement than we have currently identified.

Administrative data are quite frequently incomplete. In Western Australia, researchers used de-identified birth registration data to determine the extent of missing paternal data in birth registrations and the characteristics of families most likely to have missing paternal data, reporting that between 1992 and 2005, 14.8% of birth registrations had incomplete paternal information (e.g. age and Aboriginal status) (Sims and O'Donnell, 2015). They concluded that paternal age was not missing at random and excluding records with missing paternal information, particularly when it is not possible to distinguish between missing paternal information and paternity not being established, can introduce significant biases.

A disadvantage to using birth registrations for the primary linkage is the exclusion of children (and their fathers) who were born in another country prior to the study period, likely resulting in the underrepresentation of

migrant families. Furthermore, registration of a child's birth is required by law within 42 days in the United Kingdom, but this is not the case globally. UNICEF reports that up to 1 in 4 children under the age of 5 remain unregistered worldwide (United Nations Children's Fund, 2019). Ultimately the linkage of fathers and children is only as reliable and representative as individual datasets allow. Although there are many benefits to using administrative data, it may never be feasible to incorporate comprehensive paternal or indeed maternal involvement measures within routinely collected data sources. An important way forward would be making the linkage of administrative data and cohort studies or survey data easier, supplementing existing proxies with self-reported information from cohort studies.

Policy and research implications

We recommend that the Office for National Statistics for England and Wales investigates the potential for adding a father's NHS number to birth registrations. However, we acknowledge that this would require an act of parliament and significant effort to raise this issue on the policy agenda. An important first step towards making linkage of fathers and children more feasible on a large scale would be to put father's NHS numbers on birth notifications. NHS birth notifications are registered on the Personal Demographics Service by medical staff and include a child's NHS number, later used in the ongoing provision and recording of their care (NHS Digital, 2020). Putting the father's NHS number on the birth notification would introduce some benefits of the PIN system without imposing any legal responsibility on the father (as would be the case for birth registrations). At a minimum, there should be an option to include paternal name and contact information in birth notifications to mirror paternal information collected on birth registrations.

The implications of this recommendation to have father's NHS number on birth notifications reach beyond the immediate scope of fatherhood research. The Early Years Healthy Development Review and other research have demonstrated that new fathers do not access services or feel adequately supported, like new mothers (Baldwin et al., 2018; HM Government, 2021). Having a father's information on birth notifications would not only make data linkage easier for the good of children but enable targeted service offers to new fathers after the child is born, providing opportunities to reduce this unmet need.

In the longer term, a second stage would be to collect the father's NHS number at the first midwife appointment that typically happens around 10 weeks gestation (the 'booking appointment'). These steps would provide information on paternal access to pre- and postnatal services, which could be considered as a direct measure of paternal involvement during pregnancy within administrative data.

Further consultation is necessary to better understand the position of both mothers and fathers on these proposed changes, including consideration of practical issues around data collection and any risks this may pose to the children.

Conclusion

Linkage of paternal and child data has only been made possible in a limited number of settings globally. In countries that do not benefit from the use of PINs across national registers, the most promising method for linking fathers and children in administrative data would use both information from birth registrations/notifications and family/household links to provide the most complete picture. This method would allow for both biological and social fathers to be captured and provide information about changes in mother's partners from birth to later childhood within the anonymised data used for research.

Linkage between surveys and cohort studies and administrative data is also an important method to evaluate more detailed aspects of the fatherhood framework, including a pathway to scope the independent influences of paternal and maternal exposures on child health and development outcomes.

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ORCID iDs

Irina Lut https://orcid.org/0000-0002-9075-648X
Pia Hardelid https://orcid.org/0000-0002-0154-1306
Jenny Woodman https://orcid.org/0000-0002-9403-4177

Supplemental material

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