











OPEN LETTER

New frontiers for Biosocial Birth Cohort Research: interdisciplinary approaches to exposure, harmonisation and collaboration [version 1; peer review: awaiting peer review]

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Abstract

In this Open Letter we bring together researchers from the Biosocial Birth Cohort Research (BBCR) network to reflect on interdisciplinary research and methods within birth cohorts and to draw attention to social science approaches to this field, which we argue are underutilized. A more comprehensive and consistent integration of social science approaches would expand the scope and value of

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research with birth cohorts. We critically engage three specific areas of birth cohort research that provide significant opportunities for exchange across disciplines; how exposure is defined and measured in birth cohorts, the harmonisation of data within and between birth cohorts and the broader experience of interdisciplinary collaboration in birth cohorts and birth cohort research. By reflecting on these three areas, we highlight the need for more in-depth dialogue between life and social sciences in the design of birth cohorts, the measures that are used, and the research made possible. We argue that improving the methodological tools for measuring social and biological exposures, incorporating the complexity of participant experience, and ensuring that longitudinal studies are recognised by a wider range of disciplines are essential for collaborative biosocial research with the goal of mitigating health disparities in global and public health.

Plain Language Summary

This Open Letter brings together a group of interdisciplinary scholars from the Biosocial Birth Cohort Research Network who reflect on doing different types of research in and about Birth Cohorts which follow individuals from birth onward.

In the letter we describe about how academics from different disciplines can integrate insights from the social and biological sciences together. In particular we argue that social science could be better and more widely used in birth cohort research. Our discussion focuses on three areas; 1) how the concept of exposure could be used in birth cohorts, 2) how different kinds of data are used for comparison over time in the same birth cohort study or between different birth cohorts and 3) what the experience, possibilities and challenges are for interdisciplinary collaboration in birth cohorts.

Overall, we argue that that paying great attention to the wider context of birth cohort participants lives would contribute to public and global health.

Keywords

Birth cohorts, Biosocial Research, Interdisciplinarity, Exposure, Harmonisation, Collaboration, Public Health, Social Science

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Introduction

In this Open Letter we bring together researchers from the Biosocial Birth Cohort Research (BBCR) network¹ to reflect on interdisciplinary research and methods in birth cohorts and to draw attention to social science approaches to this field, which we argue are underutilized. A more comprehensive and consistent integration of social science approaches would expand the research scope and value of birth cohort studies.

In the 1970s and 1980s the predominant paradigm in epidemiology was the risk factor model, which identified adult risk factors for coronary heart disease and cancer, such as hypertension, smoking and physical inactivity. Inspired by Barker and colleagues, life course epidemiology, involving a more comprehensive investigation of the impact of early life exposures on later health conditions, took off in the 1990's (see [Kuh & Davey Smith, 2004](#)). These investigations have led to a significant global expansion in the establishment and creation of birth cohorts helping to deepen the epidemiological understanding of the complex multivariate, synergistic, and macro causes of ill health ([Mykhalovskiy & Weir, 2004](#)).

Birth cohorts follow individuals across their life course, collecting data on a range of social, psychological, and biological factors and exposures in order to allow a wide community of researchers to understand how environments shape health outcomes. Some birth cohorts are designed and carried out as general resources for the research community, others are developed to test specific scientific hypotheses.² The design of birth cohorts is challenging, requiring commitment over long periods of time from both researchers and participants ([Hardy et al., 2014](#); [Pearson, 2016](#)). To ensure funding over the long term, birth cohorts have had to innovate and emphasize their strengths including the capacity to study complex and inter-related health and social phenomena across the life course.

Given the richness of the longitudinal information collected by birth cohorts, they have great potential for biosocial research. While certainly not new and linked to other concepts such as the 'ecosocial' ([Krieger, 2001](#)), biosocial research has gained traction recently, defined as examining the interaction of social life with biological processes across the life course (cf [Harris & McDade, 2018](#)). While the boundaries between biosocial focused research and biomedical research are difficult to define, in general the latter has become dominated by the use of data from biobanks of large sample sizes with

extensive genomic information. However, without contextual social information, these forms of data may not always be able to address health inequalities ([Brayne & Moffitt, 2022](#)).

Alongside the expansion of 'big data' biomedical research, the range, number, and scope of birth cohorts are increasing, particularly in relation to the importance of social exposures and environments in post-genomic research, and the emphasis in life course epidemiology on the benefits of studies with a longitudinal design ([Ben-Shlomo & Kuh, 2002](#)). There is however relatively little published material on the methodological and theoretical tools used in the design of birth cohort research, and a need for a wider diverse disciplinary community to critically engage with data from these studies and contribute to their design.

In 2019, we formed the Biosocial Birth Cohort Research (BBCR) community to create a network of epidemiologists, anthropologists, and science and technology studies scholars interested in the possibilities of expanding research frameworks in, of, and with birth cohorts. We aim to address some of the challenges of interdisciplinary research in birth cohorts, to enlarge the scope of social science contribution in birth cohorts, and to reflect on how birth cohort research can be informed by closer and greater attention to the social contexts of participants' lives.

In this Open Letter we critically engage three specific areas of birth cohort research that provide significant opportunities for exchange across the life, medical and social sciences. First, we discuss how exposure is defined and measured in birth cohorts and how the collected data are used in research. Second, we examine the harmonisation of data in within and between birth cohorts, and consider what is gained and lost through this process. Third, we consider the broader experience of interdisciplinary collaboration in the context of birth cohort research.

By reflecting on these three areas, we highlight the need for more in-depth dialogue between life and social sciences in the design of birth cohorts, the measures that are used, and what this research makes possible. We argue that improving the methodological tools for measuring social and biological exposures, incorporating the complexity of participant experience, and ensuring that longitudinal studies are recognised by a wider range of disciplines are essential for collaborative biosocial research with the goal of mitigating health disparities in global and public health.

Towards biosocial exposure

Birth cohort researchers gather "exposure" data to understand how the environment shapes health. Birth cohorts examine cohort participants' exposures by collecting biological specimens to produce biomarker data and by using surveys and questionnaires or in the case of environmental exposures such as air pollution, GPS or satellite data. Analyses of these measurements help test hypotheses and establish theories about

¹ <https://bbcrnetwork.com>

² In this Open Letter 'birth cohorts' refers to those engaged in the design of and collection of birth cohort data and 'birth cohort research' refers to those who make use of birth cohort data, recognising that these can be distinctive research communities.

the association(s) between exposure(s) and health outcomes over time.

Within risk factor epidemiology, exposures are usually measured quantitatively and are most often studied as variables in analytic models, assessed for positive and/or negative associations with health outcomes (Bhopal, 2016). Exposures are commonly conceived of as substances (e.g. toxicants, food, particulates), events (e.g. natural disasters, violence), or experiences (e.g. poverty, racism, stress) that in traditional cohort studies are measured at “baseline”. Measures of exposures often assume the existence of boundaries between the environment and organisms. For instance, exposure has been defined as “a person’s contact with the concentration of a material before and after it crosses a boundary (nose, skin or mouth) between the human and the environment over an interval of time leading to a potential ‘biological effective dose’” (Lioy & Weisel, 2014: 28). Models like these place experimental intervention trials as the gold standard contributing to the dominance of univariate models of causality (Almeida-Filho, 2020).

Social and life course epidemiologists, particularly those working with birth cohorts, have challenged this linear and bounded model of exposure and advocated for moving beyond a simplistic risk factor-outcome approach to account for the occurrence of exposure events and conditions as lived through time. These researchers have critiqued the routine use of mechanistic black-box regression in biomedical research, and have pointed to the need to examine the ordering, timing, accumulation and trajectories of exposures (Ben-Shlomo & Kuh, 2002). They have also called for more complex causal modelling methods guided by theory rather than statistical “significance” (Ben-Shlomo & Kuh, 2002; De Stavola *et al.*, 2022; Victora *et al.*, 1997). Quasi-experimental impact designs are increasingly used to tackle the challenges of causal inference in life course epidemiology (Schwartz & Glymour, 2023).

In a similar vein, social scientists from anthropology, sociology, and Science and Technology Studies (STS) have developed frameworks and methods for investigating how dynamic states of health and disease are mutually constituted through human activity and environment (cf. Müller *et al.*, 2017), which are highly relevant for measuring and understanding exposure. Concepts such as the “permeable body” (Lock, 2013), the “body multiple” (Mol, 2002), “impressionable” (Meloni, 2019) and “situated” biologies (Niewohner & Lock, 2018), and humans as “becomings” rather than “beings” (Ingold, 2013) trace relationships between types of exposures and health outcomes, tethered to specific historical, economic, and political processes (Lamoreaux, 2016; Landecker, 2016; Lappé *et al.*, 2019). In foregrounding biosocial entanglements, these frameworks help to trouble the separation between inside and outside and prevent the “ontologically flattening” that occurs when social and biological exposures are translated into variables and given the same weight in aggregated scales (Landecker & Panofsky, 2013; Lappé & Jeffries-Hein, 2021). They aim

to contribute to the development of analytical models that can better calculate bi-directional influence. Informed by these frameworks, members of our network have developed biosocial methods to apprehend exposures, such as ‘syndemic research’, exposures as “trajectories”, and ‘bioethnography’ (Lloyd *et al.*, 2022; Roberts, 2019; Roberts, 2021; Roberts, 2022; Singer & Clair, 2003; Singer *et al.*, 2017).

Examining exposures in birth cohorts

Since their inception environmental health birth cohorts have collected data on chemical exposure, linking exposures to negative health impacts. Lead has been of particular interest because of its known effects on children across the lifecourse. Lead is an urgent global health problem as health organizations assert that there is no acceptable level of lead exposure because of the damage it can do to the brain, bones, and blood, especially in young children (WHO, 2021). Despite the near-total reduction of leaded gasoline use globally in the 1990’s, every person on earth still contains lead levels orders of magnitude greater than before the industrial revolution (Merrill *et al.*, 2007). Without other collective and structural efforts to regulate how industry operates, there are little means for individuals to buffer themselves from “the environment” which is continuously re-saturated with lead. Developing interdisciplinary approaches to examining lead exposure is therefore an urgent task. In **Box 1** below we examine how innovative collaborative research examining the biosociality of lead in a Mexico City birth cohort might broaden researcher’s understanding of lead exposure ecologies, by including the wider context of participants collective lives.

Box 1. The Biosociality of Lead in Mexico City

Environmental health researchers from ELEMENT (Early Life Exposure in Mexico to Environmental Toxicants), an ongoing birth cohort study in Mexico City, have demonstrated the negative impact of prenatal and early life lead exposure (Afeiche *et al.*, 2011; Perng *et al.*, 2019; Roberts, 2017). In 2013, ELEMENT began experimenting with bioethnographic methods to understand the larger ecology of lead exposure (Roberts, 2021). Early on, ELEMENT used standard environmental health methods and identified associations between eating off lead-glazed ceramic dishes and high levels of bone and blood lead in study participants. ELEMENT staff educated study participants about the dangers of eating off these dishes.

Starting in 2014, an anthropologist carried out ethnographic research in study participant neighbourhoods and began to understand more about the complex and sometimes surprising relationships which contributed to detectable lead exposure levels. Some study participants and their neighbours insisted that the leaded dishes helped them connect with each other as lead glaze imparts sweetness to foods and makes the shared dishes shine brighter. Members of these households wondered why ELEMENT focused on these dishes when so many other more contaminations in the form of pesticides and industrially caused air pollution went unalleviated. While families appreciated the data the ELEMENT study gave them about their children’s lead exposure levels, they often continued using their dishes. Some stopped using them to hold acidic foods, which draw out relatively more lead than other foods; others only used them a few holidays a year but continued to assert that these dishes have an important role in maintaining collective life.

This ethnographic finding, that participants prioritize collective life as they grapple with health in the context of their larger environment, contrasts with the approach of environmental health researchers who tend to focus on individuals as needing to maintain individual health. Insights like these have allowed ELEMENT researchers to pilot several bioethnographic projects (e.g. on water, nutrition, and cleaning products – [Roberts et al., 2024](#)) that combine life science and ethnographic methods and expand data collection about exposures beyond the individual, to household and neighbourhood levels. These studies have produced quantitative data about exposure while also providing context for what these numbers mean ([Roberts, 2021](#)).

Adverse Childhood Events (ACEs) are another kind of exposure measure well situated for a biosocial approach. Since the 1990s, research on the impact of exposure to childhood adversity on adult health has been operationalized through the lens of ACEs ([Choi et al., 2023](#)). Biomedical literature defines ACEs as “potentially traumatic events” including experiences of abuse (emotional, physical, sexual), neglect (emotional, physical), and household challenges (substance abuse, parental separation, familial abuse, incarceration, mental illness, suicide). Research has correlated ACEs with various adverse outcomes related to health, risk behaviours, and well-being over the life course, including mental health disorders, violent behaviours, cancer, and early death.

ACEs have most often been analysed using a generated score based on the number of adverse experiences reported during childhood. The score attributes equal weight to different adversities, as well as the different life stages at which they happened, leaving unexamined the differences between these events and how the historical, political, and economic dynamics of racism, sexism, colonialism, and other forms of oppression produce diverse unequal and compounded exposures ([Krieger, 2005](#); [Krieger et al., 2020](#); [Lappé et al., 2022](#)). As a result, proposed interventions in public health “often align with individually oriented interventions rather than social and structural change” ([Lappé & Jeffries-Hein, 2021](#): 458). Even when some epidemiologists call for ‘upstream’ interventions, ACEs themselves are limited to population-based assessments that are unable to assess individual differences or the potential effectiveness of interventions. Further, ACEs’ studies continue to prioritize early life ‘caregiving’ through models of the mother-child dyad which, as many scholars have shown, produces gendered accounts of intergenerational health that reproduce “mother blame” ([Lappé & Jeffries-Hein, 2023](#); [MacKendrick, 2014](#); [Richardson et al., 2014](#); [Valdez, 2018](#)). At the same time interdisciplinary research on ACEs in birth cohort research has begun to address these challenges by (a) developing new questions/measures and (b) providing better interpretation of both associations and findings as explored in [Box 2](#).

Box 2. Expanding Adverse Childhood Events ACEs research

Some biosocial researchers have argued that ACEs could expand beyond their usual focus on individual adversity and the limitations of single-adversity models by describing groups of individuals according to adversity clusters, looking at the role of social disadvantage and examining sex differences ([Lacey et al., 2020](#)). Other researchers have experimented with integrating ‘positive childhood experiences’ (PCEs) into analyses of childhood exposures, which might mitigate the effects of ACEs. These researchers seek to create a framework that reliably integrates PCEs as an experience beyond the absence of adversity and that avoids models in which PCEs might be seen as a variable that counteracts adversities in a simplistic 1:1 ratio ([Guo et al., 2022](#)).

Other biosocial researchers have drawn attention to how crucial it is to attend to the meaning of psychosocial adversity in different national contexts. For example, a study conducted in the Philippines ([Ramiro et al., 2010](#)) showed a low prevalence of physical abuse, although, in previous research, the prevalence was 40%. In the most recent questionnaire, “pushing” and “slapping”, was used to measure physical abuse, which did not reflect the experiences of respondents, for whom physical abuse involved whipping or spanking with hard objects ([Ramiro et al., 2010](#)). Similarly, adolescents directly asked general questions, for example, “Were you a victim (...)?” are likely to underreport their experiences as they do not identify themselves as a victim, but estimates are higher if a scale describing specific violent tactics is used ([Brochado et al., 2021](#)). This suggests that that different ways of measuring adversity as exposure may be necessary in different locations.

Members of our network have also explored how the ACE exposure framework can have positive effects. When practitioners in educational and juvenile correctional facilities in the U.S. reconceived disrespectful behaviours as the result of the effect of exposure to trauma rather than intentional disregard towards authority they moved away from punitive care models ([Müller & Kenney, 2021](#)). ACEs allow these practitioners to emphasize collective responsibilities for wellbeing, the need for institutional change, and the creation of social conditions that support those who have experienced exposure to early life adversity.

Harmonising data in birth cohorts

Interdisciplinary research collaborations, including within birth cohorts, are increasingly common. While the aim of such collaborations can be to increase sample size to maximise the power of statistical analyses, collaboration can also provide opportunities to illuminate, examine and intervene upon the complexity of biosocial phenomena. When researchers integrate data across cohorts, they must take multiple methodological considerations into account to ensure valid conclusions are reached regarding observed differences ([Bann et al., 2022](#)). Key among these considerations is data harmonisation, which involves achieving or improving comparability of data. Although harmonisation can be achieved prospectively through study design, more often it has to be carried out retrospectively because studies used different measurement

methods, scales and questions and often collected data at different times points in participant's lives. While data harmonisation between studies is commonly the focus, in long-running longitudinal birth cohorts, harmonisation of repeated measurements within studies is often also needed, as measurements may be required to change with participant age (e.g. cognitive tests), as new approaches to and techniques for measurement become available (e.g. lung function, blood pressure), or as the meaning of variables changes with changing social context (e.g. age at leaving education has changed over time in different national contexts).

The gains and losses of harmonisation

While there has been some harmonisation of qualitative data in birth cohorts (e.g. Elliott *et al.*, 2014) the work of harmonisation is most often deployed with so-called 'objective quantitative measurements' (e.g. biophysical measurements) or questionnaire information. The diverse disciplinary approaches of the social sciences can contribute to this process, extending critical reflection on the scope, limits and consequences of harmonisation, including the wider recognition of unharmonisable data, all to improve the harmonisation process.

Harmonisation may entail necessary simplifications, often for pragmatic reasons – which may have negative consequences on the research and that researchers do not always apprehend. First, the harmonisation of categorical variables from questionnaires across studies can lead to loss of information if the "lowest common denominator" is used, where multiple categories are reduced to produce binary variables. Further, harmonisation sometimes only includes variables that overlap across multiple studies. For example as Penkler (2022) points out, "social background or social status" in some cases is solely measured by a proxy variable such as "education of the mother", which improves harmonisation but reduces an understanding of how social determinants are linked to health outcomes.

Second, efforts at harmonisation may hinder the ability to understand diversity and vulnerability in the populations they study, as it may lead to a situation where the most vulnerable groups in the population, already under-represented in birth cohort studies, are excluded (see Box 3).

Box 3. Case study of lung function

Many longitudinal studies incorporate measures of physiological functioning, which are intended to capture 'objective' information about participants' health. For example, lung function is commonly measured using a spirometer. However, the make and model of spirometers used are rarely consistent across surveys, across the lifetime of a longitudinal study, or even within the same wave (e.g. the UKHLS used a different machines in Scotland England and Wales (McFall *et al.*, 2014)). Different devices may produce differing results even within the same individual, meaning cross-study comparisons cannot be reliably made without harmonisation (Lessof *et al.*, 2023).

At the same time, efforts at harmonisation may hinder the ability to understand diversity and vulnerability in the populations they study. Efforts to standardise lung function measurement (e.g. Miller *et al.*, 2005; Stanojevic *et al.*, 2022) may result in the systematic exclusion of individuals who may prove the most vulnerable; eg. excluding those who are unable to achieve two repeatable measures, "outliers" (especially those with extremely reduced lung function), and the adjustment or screening of those who smoke, take medication or have an existing condition. In addition, to make the measures comparable across individuals, lung function is often transformed in analyses into FEV1%. FEV1% is the percentage of an individual's predicted normal FEV1, usually calculated with reference to sex, age, ethnicity, and body size. This kind of harmonization has the potential to reify racialised categorisations and obscure the origins of disparities, as well as lose the nuance of socio-historical context (Braun, 2021; Liao & Carbonell, 2023; Moran-Thomas, 2020).

Third, some phenomena relevant to health and disease are less easily harmonisable than others, and some data may be unharmonisable. This can systematically steer the evidence base, particularly in the context of biomedical research and interventions, towards the consideration of phenomena that are perceived as more easily measurable and quantifiable (e.g., the 'objective' biophysical measurements) at the expense of more complex quantitative or qualitative forms of data better suited to capture complex biosocial processes (see Ackerman *et al.*, 2016; Penkler *et al.*, 2019). Indeed, critical social science commentators have pointed to a prevailing 'moral economy' in biomedical research, particularly as this relates to the growth and interest in biobanks, in which the production of large sets of numerical data is valued above more qualitative 'soft' data (see Ackerman *et al.*, 2016).

Fourth, harmonisation can be tied to the loss of knowledge about local contexts resulting in the comparison of things that aren't actually comparable, or false conclusions (Bann *et al.*, 2022; O'Neill & Hardy, 2024). (See Box 1 on ACES). It is especially relevant to avoid a situation in which measurements and protocols which have been developed in the global North are used as the standard that guides harmonisation efforts, thus subsuming different local contexts under a seemingly universal norm.

What is best practice and how can an inter-disciplinary perspective contribute to this?

Harmonisation efforts can consider a number of strategies and approaches to address the challenges outlined above. Engaging in comprehensive prospective harmonisation can be a useful strategy in avoiding the necessity for a least common denominator approach, with the further possibility of developing interdisciplinary collaboration for negotiating best practice. However, even when prospective harmonisation is possible, there are limits to what kinds of data are most amenable to harmonisation, as experience from the HELTI trial illustrates (see Box 4).

Box 4. Prospective harmonisation in the HeLTI Trial

Established in 2017, the Healthy Life Trajectories Initiative (HeLTI), a collaboration between the World Health Organisation, Canada, India, China and South Africa, seeks to evaluate a four-phase integrated 'preconception to early childhood' life course intervention for its effects on child overweight and obesity, alongside secondary outcomes for parental and child health. The HeLTI Consortium made significant investments to prospectively harmonise nearly all aspects of the trial, including study design; biobanking operations; monitoring using international standards for data and biospecimen collection, processing, handling and storage; training and quality control; and key outcome measures.

The process of prospectively harmonising outcomes and nearly 2000 variables across the four phases of the intervention took three and a half years and was facilitated by a consulting firm with expertise in data frameworks for epidemiological research. Variables already used in standardised tools across the sites were mostly easily harmonizable. For the primary outcome - measure of child overweight or obesity at age 5 - fat mass index is a harmonised outcome across all sites, but is measured using Dual-energy X-ray Absorptiometry scanning in the South African and Indian cohorts while other cohorts use bioimpedance. In other cases, it was necessary to negotiate operational differences in the kinds of biological data that might be collected and across which time points in different cohorts - for example the most suitable time to collect birth data differs across different sites. In many cases there was a need for the creation of flexible variables, where different social patterns across sites required crafting for relevance to all sites. For example, patterns of marriage in China and India mean that likely 100% of participants would indicate 'married' for a variable related to marital status, while in South Africa and Canada being single or unmarried but cohabiting with a partner would be more common, thus 'living with partner status', was used to indicate if the mother was living or not living with a spouse or partner. Harmonization was not possible for some of the early childhood development tools where they have been specifically designed and validated in specific languages and populations.

The attempts at harmonizing HETLI demonstrates that some data might be unharmonisable with implications for the scope of comparison and collaboration.

Interdisciplinary collaboration can contribute to the interpretation of harmonised data. Critical methodological reflection enables us to better understand the context and consequences of how birth cohort data is harmonised and ensures insights and expertise from disciplines in birth cohort research, such as anthropology, are used to increase the validity of cross-cohort research. This raises new questions and challenges, seldom discussed in cross-cohort research: How does the apparent ease of harmonisation in the case of 'objective' measures inform research trajectories and funding in birth cohort studies? Is harmonisation always necessary for comparing data? Is comparison possible without standardisation? And how can we measure the success (or failure) of harmonisation?

Addressing these underexamined issues in data harmonisation practices require a level of commitment to continuous

interdisciplinary engagement and collaboration; a theme which we explore further below.

Interdisciplinary collaboration: building alternative infrastructures for research in the birth cohort

The last two decades of health research have seen increasing calls for interdisciplinary collaborations between the social sciences, the humanities, the life sciences and public health (Filipe, 2017). Simultaneously, there has been a shift towards more engaged, democratic, and distributed forms of knowledge-making through patient and public engagement, coproduction and co-creation (Filipe *et al.*, 2017). These calls have been guided by a general assumption that collaborative work and crosscutting science not only add empirical value to research but also deepen theoretical insights and foster the effective translation and implementation of findings (Erikainen *et al.*, 2022). Birth cohort research has contributed to fulfilling these wider calls for interdisciplinary collaboration.

At the same time, based on the experiences of network members, interdisciplinary collaboration continues to prioritise quantitative-oriented disciplines. Birth cohorts, especially those dominated by biobanking initiatives, tend to use standardized and harmonized measures, prioritize measurement and statistics over qualitative methods, and focus on questions centred around biology or the individual, with social factors and cross-cultural comparisons assigned a more peripheral role (Albert *et al.*, 2017; Béhague *et al.*, 2008). One consequence of this methodological preference is that interdisciplinary collaborations often assemble distinct methods without challenging disciplinary boundaries, hierarchies, and theoretical biases (Van den Besselaar & Heimeriks, 2001).

For this reason, many have argued for forms of collaboration that integrate method and theory in order to challenge assumptions and identify new questions, hypotheses and measures (Wolf, 2015). For example, researchers continue to grapple with sampling bias and assumptions embedded in the kinds of questions and measures that are used in life course research, often reproducing assumptions common in the Global North about resources and the individual nature of health, care and aging (Alwin, 2016; Carollo *et al.*, 2021; Tesch-Römer & von Kondratowitz, 2006). Where researchers have sought deeper cross-fertilization, innovative "fields" have tended to emerge (Woiwode & Froese, 2021), such as gender studies, science and technology studies, and critical public health, transcultural psychiatry, and disability studies.

Some members of the BCCR network, have developed new ways of researching, measuring, and theorising the biosocial interface (Gibbon & Lamoreaux, 2021; see also Ingold & Pálsson, 2013; Meloni *et al.*, 2016). Box 5 illustrates how interdisciplinary collaboration can shape the design of research on body image in a Portuguese birth cohort. This emerging field of biosocial theorising and conceptualisation overlaps with similar trends in allied fields, such as life course epidemiology.

Box 5. Experience of interdisciplinary collaboration in body image

The growing field of body image studies constitutes a fertile ground for interdisciplinary collaboration. This was the case when a multidisciplinary team, including researchers from epidemiology, public health, psychology and sociology, addressed body image satisfaction in childbearing women within the birth cohort Generation XXI, assembled in Porto, Portugal, in 2005–2006 (Henriques *et al.*, 2015).

Figure rating scales such as the Stunkard silhouettes (i.e. nine separate male and female silhouettes) are commonly used in public health studies (Jayawardena *et al.*, 2021). However, the use of this tool to assess body image has been criticised across the social sciences and humanities for using reductionist, gendered and Caucasian representations of the body (see, for example, Altabe, 2001). Body image satisfaction in primiparous and multiparous mothers of the birth cohort Generation XXI was assessed with Stunkard silhouettes immediately after delivery as the difference between perceived body size before the index pregnancy and ideal body size. The research team discussed the predominance of the conventional ways of measuring body image, including importantly the limitations of the Stunkard silhouettes, which opened new spaces for mixed-methods research on body image that challenges the traditional disciplinary-based themes and practices used in Porto's cohorts.

Moving beyond the traditional relationship between advantaged socioeconomic position and lower body image satisfaction among women in Western societies, the team researched the role of mothers' social trajectory and parity in the biosocial interface SEP-body image (see also Lacey & Minnis, 2020). Additionally, hypotheses that only focused on feeling too large regarding women's ideal figure (triggered by a major public health concern with overweight and obesity) were widened to include dissatisfaction with body image by feeling too small.

This approach revealed that multiparous women who experienced a downward intergenerational social trajectory had the highest probability of being dissatisfied with their body image in either direction: feeling too large, and also too small. Social theories and attention to historical social changes were key to understand such achievement. Mothers of the birth cohort Generation XXI grew up after important national political and social changes, where many women experienced an upward social trajectory. Thus, women of this generation who experienced a downward trajectory are particularly disadvantaged, a condition that might generate dissatisfaction with body image. Without conceptual and methodological insights from psychology and sociology, it is very possible that these new hypotheses and interpretations would not have been developed.

How research contexts shape interdisciplinary collaboration

Much of the innovation in biosocial research in birth cohorts has taken place not because of but rather in spite of funding, research, and academic environments. In order to facilitate interdisciplinarity, we need a better understanding of the social, economic, and political contexts in which collaboration takes place, and how academic funding and governance structures shape the way research is conducted, the questions that are asked, the measures that are used, and how the data is interpreted. This contextualized understanding of the practice of research, drawing from science studies perspective, is vital to understanding how and why biological reductionism and individualisation in biomedical research continues despite

mainstream calls for epistemological innovation (Béhague *et al.*, 2008; Roberts, 2021).

Theoretically informed interdisciplinary collaborations remain piecemeal because such work is not built into academic research structures, nor it is properly funded or rewarded. Promotion, publication, and funding opportunities are based on peer-review processes that favour a fast-paced disciplinary metrics-oriented approach, over interdisciplinary collaboration, which often requires longer timeframe and a willingness to withstand risks and potential setbacks to researchers' careers (Woiwode & Froese, 2021). The growth of precarity in academia, NGO, and policy environments exacerbates these trends, and plays a central role in how interdisciplinary researchers view their sense of capacity and worth, and thus, their willingness to take conceptual and methodological risks (Prainsack *et al.*, 2010). In practice, then, while specific interdisciplinary teams have done much to advance complex understandings of biosocial change over the life-course, at a structural level, disciplinary boundaries, hierarchical divisions of labour, and epistemological norms that sustain disciplinary differences remain (Fitzgerald & Callard, 2015).

In this landscape, it can be a contentious, difficult, and lengthy process to develop new questions, measures, and variables that influence the mainstream of scientific practice. As described above, harmonisation seeks to ensure comparability which prioritizes standardized hypotheses, conceptual frameworks, and measures that are deemed internationally applicable and translatable. This has had the effect of side-lining interdisciplinary conceptual and methodological innovations that impede standardization. For example, the insight that “race” is not an individual “characteristic” but an indicator of systemic processes of racism (Graetz *et al.*, 2022; Jones, 2018) that requires its own set of measures and data is not easily incorporated into harmonisation efforts. Additionally, research agendas tend to privilege identifying similarities between social groups rather than differences and specificities. And when differences are highlighted, it is usually only through conventional variables – gender, age, race, education – typically interpreted in biomedical research as attributes of the individual rather than outgrowths of whole systems of structural inequity (Harvey *et al.*, 2022; Herrick & Bell, 2020; Yates-Doerr, 2020).

The regionally specific and unique interdisciplinary schools of ‘social medicine’ and ‘collective health’ in Latin America (LA) (Breilh, 2015) provide one model for how to overcome some of these limitations, both conceptually and in terms of research infrastructures. Drawing from the conceptual richness of collaboration between critical epidemiologists, historians, interculturality advocates, and social scientists, social medicine scholars emphasise how conventional “social risk factors” are far more than individual characteristics to be controlled for in regression analyses or managed through behaviour change programs. This kind of interdisciplinary collaboration has facilitated research on how intersecting forms of inequality (racial, economic, ethnic, etc.) and associated processes of marginalization produce ill health and are

themselves underpinned by broader capitalist modes of production, accumulation of wealth, and systems that are by design exploitative (Breilh, 2023).

While similar approaches are found in schools of public health and social epidemiology in other regions of the world (Waitzkin *et al.*, 2020), what makes LA social medicine unique is that its core approach and ideas are more readily found in mainstream policy and research. This is due partially to the fact that schools of social medicine are in many countries of the region integrated into publicly funded research and health care systems, and because leaders in social medicine do not shy away from engaging in the politics of health (Almeida-Filho, 2004). Social medicine scholars are also unique in that they also engage in science studies; that is, they study their own scientific concepts, theories, and tools as objects of analysis, reflexively critiquing their own fields' histories of power and bias (Martínez-Hernández & Bekele, 2023). Box 6 provides an example of how interdisciplinary research collaborations in a Brazilian birth cohort informed by social medicine theory unearthed biases embedded in scientific concepts, challenging narrow ways of understanding the causes and consequences of teen pregnancy, and developing new questions and measures altogether.

Box 6. Interdisciplinary Perspectives Challenge Teen Pregnancy Science

Epidemiological literature has repeatedly shown that teen childbearing is statistically associated with lasting mental health morbidity (Tabet *et al.*, 2016). Explanations given for this association vary considerably. Social scientists and social epidemiologists support the assertion that the negative consequences of teen childbearing are predicted largely by socio-economic precarity rather than age or psychological predisposition (Geronimus, 2003; see also Lawlor & Shaw, 2002). In contrast, psychological and neuroscience perspectives assert that adverse outcomes of teen childbearing are related to adolescent-specific brain maturation processes that predispose youth to risky behaviours (e.g. unprotected sex, alcohol and drug use) and account for adolescents' neurological and cognitive inability to cope with parenting demands, thus leading to a downward spiral of mental morbidity (Steinberg, 2007).

Interdisciplinary collaboration in the context of a longitudinal epidemiological and ethnographic sub-studies of the 1982 Pelotas birth cohort complicated both of these explanations, leading the team to reflect on biases found in the literature and to develop new research questions and qualitative and quantitative methods. The research drew from Brazilian literature that challenges expert understandings of the so-called "epidemic of teen pregnancy," and its economic and psychological causes and consequences (Heilborn *et al.*, 2002). Instead of accepting the statistical association between teen pregnancy and mental morbidity as a generalizable social or psychological fact, the team used ethnographic and epidemiological methods to explore heterogeneous pathways through which sexuality, motherhood, and emotional experience became intertwined, including those where mental morbidity did not ensue.

Ethnographic results indicated that teen childbearing and subsequent mental morbidity became intertwined *primarily* in situations where teen pregnancy has become a stigmatised object of scientific, psychiatric, societal, and public health attention. This result was then explored with epidemiological effect modification analyses, which showed that the association is more pronounced *not* amongst teens of low socio-economic status but among women who were politicised about social injustice and more critically engaged with – and thus troubled by – forms of psychological and public health knowledge that label and pathologize. These women became highly critical of the institutionalised identification of early childbearing as a key violation of life-cycle norms and of the differential racialized and class-based application of scientific psychological knowledge on its causes and consequences (Béhague, 2019; Béhague *et al.*, 2012). Using ethnographically informed hypotheses and measures, this research demonstrated that social discrimination, backed by the blame-inducing individualization focus of science, was at the heart of teen mothers' mental distress, and not merely poverty or bioneurology. These insights were made possible through transdisciplinary biosocial collaboration.

Conclusion: (Re)considering the limits of and potential for collaboration in birth cohort studies and research

Devoted to producing nonexperimental knowledge over long periods of time, a key strength of birth cohort research is its potential openness to surprising findings, new hypotheses, developing theory about how phenomena are related from the ground up, and to studying naturally arising interventions and how these have both expected and unexpected consequences in many realms of life (Timmermans & Tavory, 2012). Birth cohorts can be open to creating new local measures that may not be directly translatable to other contexts, recognizing that some phenomena are not amenable to quantification or harmonisation (Almeida-Filho, 2020), but provide excellent insight on health inequality. For instance, local measures can provide interpretive depth about mechanisms, on how things change, and how they change differently in different places or for different groups of people (Manning, 2019; Wolf, 2015). In this sense, birth cohort research has the potential to resist competitive, benchmarked research and prioritise, instead, re-embedding knowledge in a complicated world, encouraging scientists and researchers to see and further explore "what is messy", in both quantifiable and qualitative data, not as something to be tamed but as a reality to learn to think with (Stengers, 2017).

To encourage conceptually hybrid research, we suggest building new 'interdisciplinary' research infrastructures in three key ways. First, forming interdisciplinary teams from the onset of cohort design and planning would allow for a biosocial approach from the outset (Roberts, 2021). Engaging with and supporting early career researchers in developing more effective interdisciplinary dialogue and research when using birth cohort data is also vital, something that the BBCR

network is actively committed to undertaking in its focused training and student led activities over the last few years.³

As noted above, however, the learning from and showcasing the innovations of specific interdisciplinary teams is only a first if vital step towards more sustainable infrastructural change. Therefore, we call for a second aim: use of a science studies approach to investigate how birth cohort research and those who design and manage them reproduce but also can disrupt normative ways of thinking and doing in science. Researchers engaged in interdisciplinary collaborations have been shown to cope with the structural pressures of mono-disciplinarity in highly variable ways (Woiwode & Froese, 2021); what accounts for those differences? How do researchers interested in interdisciplinary research navigate this terrain, including the relational dimensions of trust/distrust generated by epistemological differences that separate disciplinary boundaries (Leighton & Roberts, 2020)? In what specific relations and ecologies do such diverse birth cohort research communities become trapped into practices that reproduce reductive ways of producing knowledge about the causes of ill-health (Lloyd *et al.*, 2020; Roberts, 2022), and how and why do researchers who both design and use birth cohort data sometimes break away from these very ecologies (Béhague & Storeng, 2013)?

Third, by drawing on detailed understanding of the specific conditions and environments that enable researchers to take risks, break disciplinary boundaries down, and challenge scientific assumptions, we can more effectively intervene upon and improve infrastructures for conceptual interdisciplinary exchange (Graff, 2015). For example, building from research conducted in the Global South, birth cohort researchers are challenging the over-riding emphasis that DOHaD informed epidemiological research has placed on motherhood and the maternal realm as both locus of ill-health and primary point of intervention (Pentecost & Ross, 2019; Sharp *et al.*, 2018). To systematically facilitate methodological and conceptual shifts such as these, we need more than debate and concept-work. We need to influence donor policies and practices, as well as

challenge and modify academic hiring, promotion criteria, and traditional publication models in ways that allow researchers to innovate through interdisciplinary exchange. Working collaboratively with study participants as interlocutors and citizen scientists is also vital (Bieler *et al.*, 2021).

Though several birth cohorts have already engaged in participatory methods (Dogra *et al.*, 2023), given the need for lifelong participation, there is scope to expand and improve on such efforts, particularly as it relates to developing new hypotheses and theories. Amplifying funding mechanisms that are not reliant on the priorities and perspectives of major donors, such as crowdfunding citizen science initiatives and emerging data sovereignty initiatives would be another key area of intervention (Prussing, 2020). These kinds of changes take time, however, and commitment to “slow research,” to mitigating against the scientific community and donors’ demands for immediate returns on research investments (Adams *et al.*, 2014; Mountz *et al.*, 2015; Parhi, 2023; Stengers, 2017). They also require, as Debbie Lawlor and colleagues argue, some generosity by present-day researchers, “who may not witness, nor gain credit for, the benefits of their foresight and labours in their own working life” (2009: 900).

In summary while progress has been made in incorporating different disciplinary research and methods within cohorts much more needs to be done to realise the potential of birth cohort research for understanding the true complexity of the life course. In this Open Letter we have showcased the activities and commitment of the BBCR network to facilitate the incorporating of social science methods into birth cohort design and research. We seek to better build infrastructure for collaborations across North/South divides to support, expand and fully realise the utility and value of truly biosocial research in birth cohort studies.

Data availability

No data are associated with this article.

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³ See for example the BBCR Early Career Network seminars <https://bbcrnetwork.com/podcasts-talks/>

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