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Birth Intention Status and Infant Mortality: Fixed-Effects Analysis of 60 Countries

HEINI VÄISÄNEN  AND EWA BATYRA 

Most studies on the impact of birth intentions on children's well-being do not separate risks of infant mortality associated with pregnancy intention status from the risks that are associated with sociodemographic characteristics. There is a lack of studies taking a multicountry comparative perspective. We analyzed 60 Demographic and Health Surveys in Asia, the Americas, and Africa to examine the association between birth intentions and infant mortality using sibling fixed-effects linear probability models accounting for confounding due to time-invariant maternal characteristics. Compared to wanted births, the probability of infant mortality was higher after an unwanted or mistimed birth, or both, in 41 countries. Particularly in West Africa, mostly mistimed pregnancies were associated with infant mortality, whereas in the Americas unwanted pregnancies mattered more. These differences could be partly due to contextual variation in the concept of birth intentions and in the importance of birth spacing and limiting. We show that the risk of infant mortality after an unwanted/mistimed pregnancy was higher in countries with low human development index and high overall infant mortality rate, highlighting the importance of taking context into account rather than pooling data. To the best of our knowledge, this is the first large-scale, cross-regional, and cross-country comparative study to analyze the association between birth intentions and infant mortality using a fixed-effects approach.

Introduction

There is a longstanding interest in understanding the association between pregnancy intentions and children's well-being. Unintended pregnancy rates have decreased across the world in the last decades, but they remain high, especially in Africa and Latin America (around 90/1000 women and

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70/1000 women, respectively, in 2015–2019) (Bearak et al. 2022; Sedgh, Singh, and Hussain 2014). Even though unintended childbearing is relatively common, systematic literature reviews highlight that the relationship between pregnancy intentions and pregnancy outcomes in many parts of Africa, Latin America, and Asia remains poorly understood and that there is insufficient knowledge on whether these relationships differ across settings (Gipson, Koenig, and Hindin 2008; Hall et al. 2017).

Existing studies usually start from the premise that children born following unplanned pregnancies could be at higher risk of negative health outcomes, but the resulting empirical evidence is inconsistent. The difficulty in concluding whether pregnancy intentions are important for children's outcomes stems from two limitations of the existing research. First, many studies on the topic suffer from the difficulty of separating the effect of pregnancy intentions status from the sociodemographic characteristics typically associated with such intentions as well as children's well-being (Dibaba, Fantahun, and Hindin 2013; Gipson, Koenig, and Hindin 2008). Few studies account for this unobserved heterogeneity, that is, the unobserved characteristics associated with both the predictor and the outcome, which can bias their estimates. Second, there is currently a dearth of large-scale, cross-country, and cross-regional comparative research on the topic that could cast light on whether differences in conclusions between the existing, predominately single-country studies, are due to methodological differences, or because the risks truly vary by context.

In this study, we aim to address these shortcomings. First, using a methodological approach that allows us to account for time-invariant unmeasured confounding, we investigate whether unintended births are associated with the risk of infant mortality. We use fixed-effects sibling comparison models to control for all time-invariant maternal characteristics. Second, by focusing on 60 countries across Asia, the Americas (excluding the United States and Canada), and Africa, we uncover whether the consequences of unintended births differ by regional or country context.

By *unintended births* in this study, we mean pregnancies that ended in live births and were either not wanted at all (*unwanted*) or were wanted later (*mistimed*) at the time of conception, which we identify based on the retrospective reports of birth intentions status. The main outcome is infant mortality, that is dying before one's first birthday. We chose infant mortality because it is one of the key indicators used to track improvements in child and population health. Because of the undisputable importance of ending preventable early-life deaths, it is a metric that is widely available even in resource-poor contexts.

Our focus on early-life mortality is motivated not only by the fact that it is a pressing health problem featuring prominently in the Sustainable Development Goals (SDGs) agenda (United Nations 2016) but also because many of the settings this paper concerns carry a particularly heavy early-life

mortality burden. In 2020, the infant mortality rate (IMR) for sub-Saharan Africa and Southern Asia was 51 and 31 per 1000 live births, respectively, which is around eight to ten times higher than in Europe and Northern America (UN Inter-agency Group for Child Mortality Estimation 2021). Given the insufficient improvements and the prospect of many countries failing to reach the SDGs related to child mortality reductions, there is a call for action to advance knowledge of the factors contributing to these high levels of early-life mortality. In this paper, we aim to rigorously explore whether, and if so, where birth intentions matter for infant mortality. Our results will be of interest to academics and policymakers aiming to improve child health.

Background

Unintended pregnancies and early mortality

Previous studies have examined whether birth intention status is associated with early-life mortality (including neonatal, infant, and child mortality) in the world regions of interest to us. However, most of these studies did not use methodologies that would disentangle whether these outcomes were due to the unintended birth itself or rather due to sociodemographic characteristics associated with both the likelihood of unintended pregnancy and early mortality. Such studies in Asia, Americas, and Africa suggest, for instance, that there is no association between having a birth after expressing an intention to stop childbearing and mortality before age three in Matlab in Bangladesh (Bishai et al. 2015); retrospectively measured birth intention status (wanted, mistimed, unwanted) and early-life mortality in Dominican Republic, Egypt, Kenya, Philippines, or Thailand (Montgomery et al. 1997); or the London Measure of Unplanned Pregnancy (see Barrett, Smith, and Wellings 2004) and neonatal mortality in Malawi (Hall et al. 2018). On the contrary, in India, an association between being unwanted/mistimed and neonatal and infant mortality was found (Singh, Singh, and Mahapatra 2013).

Few studies have used analytic strategies, such as sibling fixed-effects models, to separate the effect of pregnancy intention status from the sociodemographic characteristics typically associated with such intentions and early mortality. These models typically control for stable maternal characteristics, which could otherwise bias the results. We found three studies in Asia or Africa using fixed-effects models to examine birth intentions and early-life mortality (Chalasanani, Casterline, and Koenig 2007; Flatø 2018; Singh et al. 2012). In India, unwanted and mistimed births were associated with a higher infant mortality risk (Singh et al. 2012). Chalasanani, Casterline, and Koenig (2007) documented excess infant mortality of children born as a result of unwanted pregnancy in Bangladesh. In both studies,

authors identified unintended pregnancies using a retrospective question about birth intention status. Taking a different approach, a study pooling data from 33 countries in sub-Saharan Africa found that siblings exceeding the ideal number of children in the family, the ideal number of children of that gender, or both, had an increased risk of infant mortality compared to those born at lower parities (Flatø 2018). The author focused on the overall pattern across all sub-Saharan African countries combined, and the results by country were shown for eight nations with the highest share of infant mortality attributable to undesiredness, which were located almost entirely in the southern part of the continent.

Overall, there has been little research taking a multicountry comparative perspective and focusing on different world regions, which could shed light on the importance of the country context for the variation in this association across the globe. It should also be noted that most of the studies mentioned did not explicitly consider mistimed pregnancies (i.e., instead they combined mistimed and unwanted ones) or did not consider mistimed pregnancies at all (Bishai et al. 2015; Chalasani, Casterline, and Koenig 2007; Flatø 2018; Hall et al. 2018; Singh, Singh, and Mahapatra 2013), limiting our understanding of the variation in the link between birth intentions and early-life mortality. This is particularly relevant in light of studies showing heterogeneous associations between mistimed and unwanted pregnancies to other health outcomes such as preterm birth and low birth weight, and urging researchers to thus examine mistimed and unwanted pregnancies separately (D'Angelo et al. 2004; Kost and Lindberg 2015).

Our study contributes to the existing literature by employing a consistent methodological approach—fixed-effects sibling comparison models—to examine whether unintended births are associated with the risk of infant mortality across 60 countries in Asia, the Americas, and Africa. We also deliver a much more detailed account of the variation in this association than in previous studies: First, we distinguish between mistimed and unwanted pregnancies. Second, we explore contextual variation by presenting the results for broader regions, by country, and by studying differences between nations at different levels of development. As a result, we provide a comprehensive picture of which unintended pregnancies, and where, are the most relevant for child survival.

Measuring pregnancy and birth intentions

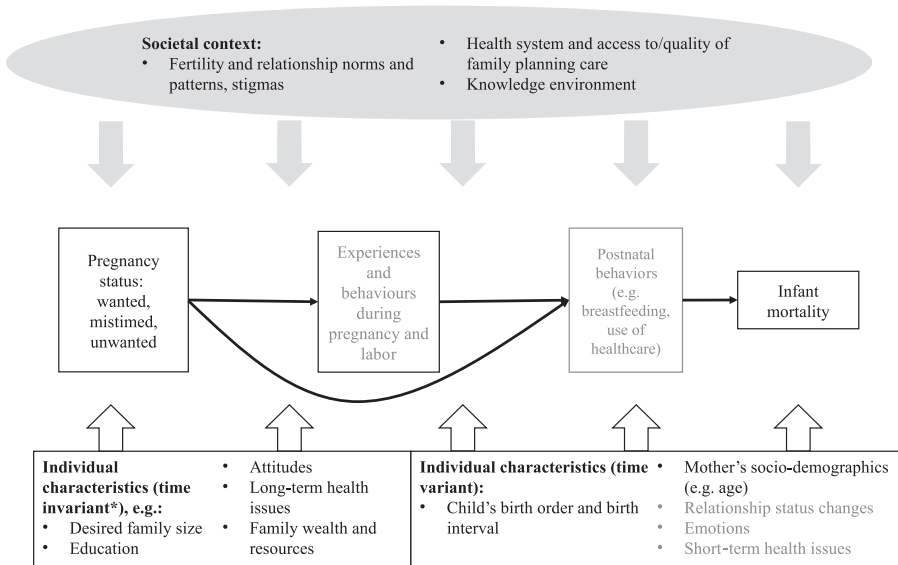
There are many studies highlighting the challenges of examining pregnancy intentions as well as the strengths and limitations of various approaches aiming at capturing them. We use women's retrospective reports of birth intention status, as this measure is most suited for the purpose of our study, which we explain below.

Both retrospective and prospective measures are designed to capture pregnancy intentions at the time of conception, but they have limitations. The main shortcoming of retrospective measures is that they can suffer from recall bias that leads to the underestimation of levels of unintended births (Bankole and Westoff 1998; Koenig et al. 2006). Prospective reports are not subject to recall issues, but they can also be biased if women alter their fertility desires between the time they were first surveyed and when the data on pregnancies were collected (Bishai et al. 2015). Another key shortcoming of prospective reports for the purpose of our study is that their availability is limited. Retrospective reports are widely available from the Demographic and Health Surveys (DHSs) which allow for comparative analyses.

An issue that should nonetheless be highlighted when studying birth intentions and early-life mortality using retrospective questions is a potential bias in reports related to deceased children. Smith-Greenaway and Sennott (2016) found that mothers may be less likely to report a child as “unintended” if the child has died. They hypothesize that this could be due to women seeing these pregnancies in a more positive light following a child’s death or/and not being comfortable reporting such pregnancies as unintended in face-to-face interviews. They also observed that, although all deceased children were less likely to be reported to have been born as the result of an unintended pregnancy, this was especially the case for children who died at older ages. Even though the bias is most pronounced for older ones, children who died shortly after birth—the focus of our study—might still be more often classified as having been wanted at the time of pregnancy than those who survive. This issue may result in underreporting of unintended pregnancies, a limitation that has to be kept in mind. Nonetheless, it should also be noted that the misclassification of unintended pregnancies as intended means that our estimates of the risk of infant mortality among unintended births are likely to be conservative.

Another approach to capture undesired pregnancies is by defining children as “in excess” based on information about ideal family size and the number of existing children (Flatø 2018). This involves using a question asking women to go back in time before childbearing and state the ideal number of children that they would have liked to have in their whole life, irrespective of the number they already have. Children of order higher than ideal are subsequently classified as undesired. This approach also has limitations. As retrospective questions, it can be affected by ex post realization: recent research on Malawi highlights a large degree of instability in desired family size throughout women’s life course (Müller et al. 2022). Importantly, this approach does not permit identifying the intentions status of a specific child regardless of their birth order. Rather, all children of order higher than ideal family size are classified as undesired. Such a definition does not allow accounting for the fact that lower order pregnancies can be unintended at the time of conception (e.g., they happened earlier than

FIGURE 1 Conceptual framework: pathways from birth intentions to infant mortality



NOTES: The conceptual framework is adapted from Gipson, Koenig, and Hindin (2008). The gray text means that we were not able to measure or otherwise control for that aspect in our study. *Some of the characteristics in the “time-invariant” box may change over time, but we assumed these would stay relatively constant within the five-year period of the study (see the section Data and Methods).

desired, which may affect birth outcomes), even though they did not exceed the ideal family size. We consider information about the birth intention status of all children, including those at lower parities, to be important for conducting sibling comparisons.

Overall, although retrospective reports of birth intention status measure intentions have limitations, they are designed to capture pregnancy intentions at conception, they refer to each specific child thus capturing intentions across births of all parties, and they permit distinguishing between unwanted and mistimed births. Because of these properties and their wide availability in surveys, they are the most appropriate from the available measures for conducting a large-scale, cross-country, and cross-regional analysis using fixed effects, as aimed in this paper.

Conceptual framework

Our conceptual framework (Figure 1) is adapted from that of Gipson, Koenig, and Hindin (2008), which identifies the potential associations between unintended pregnancy and infant, child, and parental health outcomes. Our framework displays contextual as well as individual-level factors affecting the likelihood of infant mortality following births of different intention statuses: wanted, unwanted, or mistimed. There are many

individual-level characteristics, which may affect both pregnancy intention status and infant mortality. Thus, it is important to use study designs that take this heterogeneity into account.

Pregnancy intention status is associated with individuals' experiences and behaviors during pregnancy, labor, and the postnatal period, which may, in turn, be associated with the probability of infant mortality. For the sake of brevity, in this section, we highlight some of the possible channels, although it should be noted that there might be various and interconnected paths through which unintended pregnancy could be linked with our outcome. For example, unintended pregnancies were associated with a smaller likelihood of giving birth with a skilled attendant in India (Chatterjee and Sennott 2020; Singh et al. 2012) and lower or later antenatal care attendance in Bangladesh, India, Ethiopia, Namibia, and Iran, as well as in a multicountry study in Africa (Amo-Adjei and Tuoyire 2016; Chatterjee and Sennott 2020; Kamal, Hassan, and Islam 2013; Khajehpour et al. 2013; Thogarapalli et al. 2016; Wado, Afework, and Hindin 2013). In the United States, unintended births were associated with heavy smoking during pregnancy, delayed prenatal care, and lower likelihood of breastfeeding (Joyce, Kaestner, and Korenman 2000), which may partly be due to such pregnancies often being recognized with a delay (Kost, Landry, and Darroch 1998). Moreover, ever experiencing an unintended pregnancy was linked to a mother's lower psychological well-being in Indonesia (Hardee et al. 2004). Finally, in India, children born from unintended pregnancies were less likely to receive immunizations (Singh et al. 2012). Overall, as highlighted by Montgomery and Lloyd (1996), unintended pregnancy may bring unanticipated constraints on family resources (e.g., family income, parental time, mother's physiological and nutritional resources) and influence expenditures on children's health, all of which are important for early survival. While we are not able to explicitly study these experiences and behaviors here, we believe they are important in explaining the mechanism linking pregnancy intention status with infant mortality (Figure 1).

The societal context in which the individuals live is also likely important for the relationship between birth intention status and infant mortality. Norms and stigmas around fertility and sexuality may affect pregnancy intentions as well as decisions to either abort or carry an unintended pregnancy to term (Väisänen and Batyra 2022). The wider level of "development" of the country has been shown to affect the associations between other variables, such as birth intervals and infant mortality (Molitoris, Barclay, and Kolk 2019): the negative effects of shorter birth intervals were mitigated in contexts with higher levels of development. In our study, we hypothesize that, in countries with better overall, social, economic, and health conditions, it may be easier for women to deal with difficulties arising from becoming pregnant unintendedly as well as accessing healthcare services at different stages of pregnancy. Such improved contextual circum-

stances could increase the survival chances of children born as a result of unintended pregnancy.¹ Thus, in addition to conducting our analyses of the association between birth intention status and infant mortality by wider world regions, we examine how this relationship varies by country and whether it varies by levels of “development” as measured by the overall IMR and the human development index (HDI).

Our research questions are as follows:

- (1) Is birth intention status associated with the risk of infant mortality when time-invariant maternal characteristics are controlled for in Africa, Asia, and the Americas?
- (2) To what extent does this association vary by context (i.e., between regions, countries, and by countries’ level of “development”)?

Since there are some individual-level characteristics and behaviors that may vary over time and that we cannot control for due to data unavailability (Figure 1), we do not claim to be able to prove a direct *causal link* between pregnancy intentions and infant mortality. Nevertheless, this study goes beyond existing literature by combining the sibling fixed-effects design and a large-scale, cross-regional, and cross-country analysis. This improves our understanding of the potential implications of unintended pregnancies and how these may vary across the globe. While the sibling fixed-effects design cannot control for unobserved *time-variant* characteristics, it can control for any *time-invariant maternal* characteristics potentially affecting both pregnancy intentions and early mortality, which the approaches applied in most existing studies cannot do. Therefore, our approach tackles an important limitation in previous research and a gap in our understanding. However, we do recognize other approaches have their own advantages and think the different approaches complement each other.

Data

We used individual women recodes of the DHSs that were collected in Asia, Africa, and the Americas between the years 2000 and 2020 and that included information on pregnancy intentions of all births that happened within a five-year period preceding the survey. We excluded surveys that collected data about ever-married women only. For each of the 60 countries covered by our analysis, we use the most recent DHS available. The list of surveys used and the years in which they were collected, as well as regional groupings that follow the DHS classification of world regions, can be seen in Table 1.

Our outcome variable is *infant mortality*, which is the death of a child before the age of 12 months. Our main explanatory variable is *pregnancy intention* from the DHS maternity history, which classifies the intention

TABLE 1 Distributions of the main variables in the analytic sample, percent, and N

	DHS year	Infant mortality (%)	Infant mortality (N)	Mistimed, (%)	Mistimed (N)	Unwanted (%)	Unwanted (N)	Number of Children
Africa East		5.0	3233	24.0	15620	6.6	4101	65445
Burundi	2016–2017	4.8	374	26.4	2188	7.6	576	8056
Comoros	2012	3.4	62	26.5	495	6.5	135	1828
Ethiopia	2016	5.1	324	17.8	692	7.4	254	6024
Kenya	2014	4.6	217	24.9	1161	9.8	419	5093
Madagascar	2008–2009	4.9	348	7.5	534	4.1	275	6832
Malawi	2015–2016	5.3	353	30.1	2071	9.2	609	6652
Mozambique	2011	6.1	378	8.9	650	2.0	162	6037
Rwanda	2019–2020	4.1	142	31.8	1067	12.6	432	3414
Tanzania	2015–2016	4.5	238	29.9	1689	3.9	182	5503
Uganda	2016	4.4	409	33.3	3010	8.3	749	9190
Zambia	2018	5.2	237	30.8	1411	3.6	165	4567
Zimbabwe	2015	7.1	151	29.9	652	5.5	143	2249
Africa West		6.1	5022	12.7	10413	2.6	2231	83192
Benin	2017–2018	5.3	406	17.9	1390	5.0	396	7765
Burkina Faso	2010	6.7	558	6.5	542	1.1	89	8246
Gambia	2019–2020	4.2	204	18.8	772	1.2	67	4521
Ghana	2014	4.9	131	24.1	562	6.6	159	2668
Guinea	2018	7.2	286	10.7	455	2.5	121	4163
Côte d'Ivoire	2011–2012	6.8	273	20.2	763	3.3	108	3869
Liberia	2019–2020	7.8	208	29.5	694	6.9	183	2444
Mali	2018	5.6	337	12.4	697	2.2	132	6196
Mauritania	2000–2001	7.5	175	24.5	689	6.0	159	2697
Niger	2012	4.5	377	9.0	763	0.5	54	8503
Nigeria	2018	6.8	1427	7.6	1576	1.8	399	20996

/...

TABLE 1 (Continued)

	DHS year	Infant mortality (%)	Infant mortality (N)	Mistimed (%)	Mistimed (N)	Unwanted (%)	Unwanted (N)	Number of Children
Senegal	2018	3.4	129	14.8	497	2.2	70	3527
Sierra Leone	2019	8.8	347	8.5	351	3.2	126	4274
Togo	2013–2014	4.9	164	22.2	662	5.6	168	3323
Africa central and south		5.4	2849	21.6	11391	5.1	2736	53991
Angola	2015–2016	4.6	399	26.4	2283	4.5	398	9340
Cameroon	2018	5.1	303	16.6	970	3.3	214	5536
Chad	2014–2015	6.7	808	10.2	1156	0.8	114	12897
Congo	2011–2012	3.8	197	24.1	1140	2.7	134	4858
Democratic Republic of Congo	2013–2014	5.2	671	22.9	2719	4.1	519	12543
Gabon	2012	3.5	108	37.4	1167	5.4	182	3133
Lesotho	2014	8.4	81	32.2	304	21.6	200	948
Namibia	2013	4.7	87	40.9	716	9.6	203	1846
Sao Tome and Principe	2008–2009	2.7	23	37.2	291	17.8	130	803
South Africa	2016	6.0	57	33.0	305	24.4	217	890
Eswatini	2006–2007	9.4	115	27.7	340	36.2	425	1197
Africa North								
Morocco	2003–2004	5.1	123	20.8	481	13.2	323	2431
Americas central		4.0	653	27.5	4487	20.2	3401	16498
Dominican Republic	2013	3.1	49	35.7	463	14.5	170	1333
Guatemala	2014–15	3.4	171	24.2	1300	15.4	820	5251
Haiti	2016–17	7.2	169	29.0	723	27.2	725	2594
Honduras	2011–12	3.1	133	33.5	1293	15.7	618	3960
								/...

TABLE 1 (Continued)

	DHS year	Infant mortality (%)	Infant mortality (N)	Mistimed (%)	Mistimed (N)	Unwanted (%)	Unwanted (N)	Number of Children
Nicaragua	2001	3.9	131	21.7	708	30.4	1068	3360
Americas south								
Bolivia	2008	4.2	415	29.3	3221	32.7	3660	11133
Colombia	2015	6.3	228	25.7	1041	41.7	1581	3976
Guyana	2009	2.9	88	32.3	1011	26.4	989	3228
Peru	2012	2.6	20	24.6	196	19.1	214	981
Asia south and southeast								
	2012	2.6	79	33.4	973	29.2	876	2948
		5.1	7422	5.7	8212	4.6	6264	144452
Cambodia	2014	4.3	91	13.0	274	5.8	121	2289
India	2015-16	5.3	6670	4.8	6058	4.3	4993	124624
Indonesia	2017	4.4	195	13.0	594	8.9	332	4473
Maldives	2016-17	2.7	22	25.1	194	9.4	66	798
Myanmar	2015-16	7.2	111	4.4	79	6.5	74	1679
Nepal	2016	5.4	106	12.8	243	6.9	137	1890
Philippines	2017	2.4	101	16.9	686	11.5	463	4590
Timor-Leste	2016	3.0	126	2.4	84	2.3	78	4109
Asia central and west								
Armenia	2015-16	2.8	238	6.6	566	3.4	333	8741
		0.7	5	9.2	53	0.5	2	603
Azerbaijan	2006	4.9	50	12.9	134	6.5	71	1092
Kyrgyzstan	2012	3.0	69	4.1	83	0.2	6	2197
Tajikistan	2017	2.7	95	3.0	115	1.4	58	3521
Türkiye	2013	1.4	19	15.7	181	13.5	196	1328

status of each birth that happened within five years of the survey into wanted, mistimed (wanted later), or unwanted at the time of conception. This information is based on women's retrospective reports and aims to reflect their intention to have a child before becoming pregnant.

When it comes to the analytic sample selection process, we excluded nonsingleton births (i.e., twins, triplets, etc.), as children born as a result of multiple pregnancies are known to differ in their risk of early-life mortality from those from singleton pregnancies (Bellizzi et al. 2018; Uthman, Uthman, and Yahaya 2008). Moreover, due to our analytic strategy (see details below), we restrict the sample to mothers (and their children) who had at least two live births within the five years preceding the survey and for which their birth intention status was known. Overall, our analytic sample selection process led to the inclusion of 385,883 births, that is, 44 percent of all the 877,007 births recorded in the DHSs in the five years before each survey (see Online Appendix Figure A1 for details). As such, the results cannot be generalized to *all* mothers, which is a limitation of our analytic strategy (see below). However, our analytic sample did not differ much in their birth intentions from all women who had a birth in the last five years, although their IMRs were slightly higher (Online Appendix Table A1).

As explained above, information about intentions is not available for pregnancies that resulted in live births more than five years before the survey date. Yet, as the median birth interval in the vast majority of countries we focus on is below 50 months (StatCompiler; Measure DHS 2022), experiencing two births within a five-year period is not unusual. Moreover, analyzing births relatively close to the survey date reduces concerns of recall bias. This is particularly relevant for our study given previous evidence that the recall bias concerning birth intention status following a child's death increases with the child's age (Smith-Greenaway and Sennott 2016). Finally, focusing on births close to the interview means that the context of infant mortality in each country will be relatively similar for all births concerned.

We include a set of control variables that may vary between children born to the same mother. We derive variables that are available in DHSs and may be associated with both birth intention status and early-life mortality: mother's age at the time of birth, child's sex, and child's birth order (Adetunji 1998; Boco 2014; Coffey and Spears 2021; Finlay, Özaltın, and Canning 2011; Hussain, Fikree, and Berendes 2000; Jiang, Li, and Sánchez-Barricarte 2016; Kashyap and Behrman 2020; Rutstein 2000; Titaley et al. 2008; Uddin and Hossain 2011). As described in the Background section, we were not able to control for all time-variant characteristics of interest, as comparative data were not always collected. For example, we have data only about current marital status; antenatal and postpartum visits are collected for the last pregnancy only; and information about breastfeeding practices is available only for children who are currently being breastfed. These data shortcomings, as well as limited country coverage, and a large

number of missing values for some variables, also preclude extending our large-scale comparative study to other child outcomes (e.g., immunization or birth weight).

Finally, we use data from two external sources to study the variation by “development” level in the association between birth intentions and infant mortality. First, we use estimates of IMR as published by DHS in StatCompiler (Measure DHS 2022) for each country survey that we use. Second, we use the HDI from the United Nations Development Programme’s Human Development Reports (UNDP 2022). We match the HDI value to each country based on the year the survey was conducted.

Methods and analytic strategy

We use sibling fixed-effects linear probability models to estimate if birth intention status is associated with the risk of infant mortality using the following equation:

$$Y_{ij} = BIS_{ij}\beta_{1,ij} + \mathbf{X}_{ij}\beta_{k,ij} + u_j + e_{ij}. \quad (1)$$

The outcome variable Y in Equation (1) is a binary variable indicating whether child i to mother j died before their first birthday. Birth intention status indicates whether each child i to mother j was wanted, mistimed, or unwanted at the time of conception. The vector of control variables \mathbf{X} includes the mother’s age at the time of birth, the child’s birth order, and sex. Adding a mother-specific fixed intercept u_j controls for all, time-invariant maternal factors and means we are comparing the pregnancy intention status of siblings born to the same mother. This modeling strategy can thus be used to address the endogeneity issues arising from birth intention status being correlated with the same stable, unobserved maternal factors as infant mortality.

After running descriptive analyses to characterize our sample, we conduct a set of fixed effects regression models, first separately by DHS region,² and then by each country. We ran separate analyses because regions or countries do not vary between siblings and thus cannot be included as explanatory variables in the models. We express the results of our analyses as predicted probabilities of infant mortality by birth intention status while holding the control variables at their means. These probabilities are interpreted and discussed on their own, as well as plotted with contextual variables of interest: IMR and the HDI in each country. The plots help us understand the links between contextual factors and the association between birth intention status and infant mortality.

Finally, we conduct sensitivity analyses. First, we control for the preceding birth interval (in months as a continuous variable, allowing for a quadratic nonlinear effect), which is a predictor of both our main explanatory variable (Adetunji 1998) and outcome (Molitoris, Barclay, and Kolk

2019; Rutstein 2000; Titaley et al. 2008). To implement this analysis, we restrict our sample to women who had at least three births, as done in previous research using fixed-effects models to study other predictors of infant mortality (Molitoris, Barclay, and Kolk 2019). This is necessary to obtain a birth interval for all siblings of interest. The DHS provides information about birth intervals of all births, regardless of their timing. Thus, while we still focus on women who had at least two births within the five-year window prior to the survey date—to have information about the birth intention status—the birth of the third child (i.e., the lowest order birth) could have happened at any point in time.

We also ran sensitivity analyses testing whether our results could have been biased by right censoring, that is, by some births having taken place less than a year before the interview date thus meaning that these children were not exposed to the risk of infant mortality as long as those who were born at least a year before the interview.³ We conducted analyses including only births that happened at least a year before the interview date and analyses using neonatal mortality (i.e., death within a month of birth) as the outcome. Finally, we examined nonlinear effects (using both step-functions and polynomials) and interactions for two control variables (age and birth order) to see whether the association between birth intention status and infant mortality differs based on these characteristics.

Results

Descriptive statistics

Table 1 shows descriptive statistics for our analytical sample (385,883 children and 182,659 women). By country, the sample sizes varied from 603 children in Armenia to 20,996 in Nigeria. Overall, infant mortality, defined as the percentage of children who died before the first year of life within our analytic sample, was lowest in Central and West Asia (2.8 percent), followed by Central and South America (~4 percent). Infant mortality was highest in Africa, and its western parts in particular (6.1 percent). At the country level, the lowest level of infant mortality was reported in Armenia (0.7 percent) and the highest in Eswatini (9.4 percent).

There was substantial variation in the percentage of mistimed and unwanted births across the regions. Fewer mistimed births occurred in South, Southeast, Central, and West Asia (around 6 percent) compared to other areas, whereas on average the proportion of unwanted births was lowest in West Africa (2.6 percent). In all African regions, the proportion of unwanted births was much lower than mistimed ones. In the Americas, there was a relatively high proportion of both mistimed and unwanted births (>20 percent). The highest level of mistimed births in our dataset is found in Namibia (41 percent) and the highest level of unwanted births in Bolivia (42 per-

cent). The lowest levels were found in Timor-Leste (2.4 percent for mistimed births) and Kyrgyzstan (0.2 percent for unwanted births) (Table 1).

Figure 2 shows the percentage of births in our analytic sample, where the infant died before their first birthday, by birth intentions status. There are large variations between regions and countries. While in the majority of Central and Southern African countries, the percentage of children who die before the first year of life is generally higher for mistimed and unwanted births, as compared to wanted ones, the opposite tends to be the case in most West and East African countries. Nonetheless, there is substantial variation within regions. For example, in Central and Southern Africa, a higher percentage of mistimed than wanted pregnancies was followed by infant death in Cameroon, but the association was reversed in Gabon. The results for specific countries in the Americas and Asia are also quite mixed.

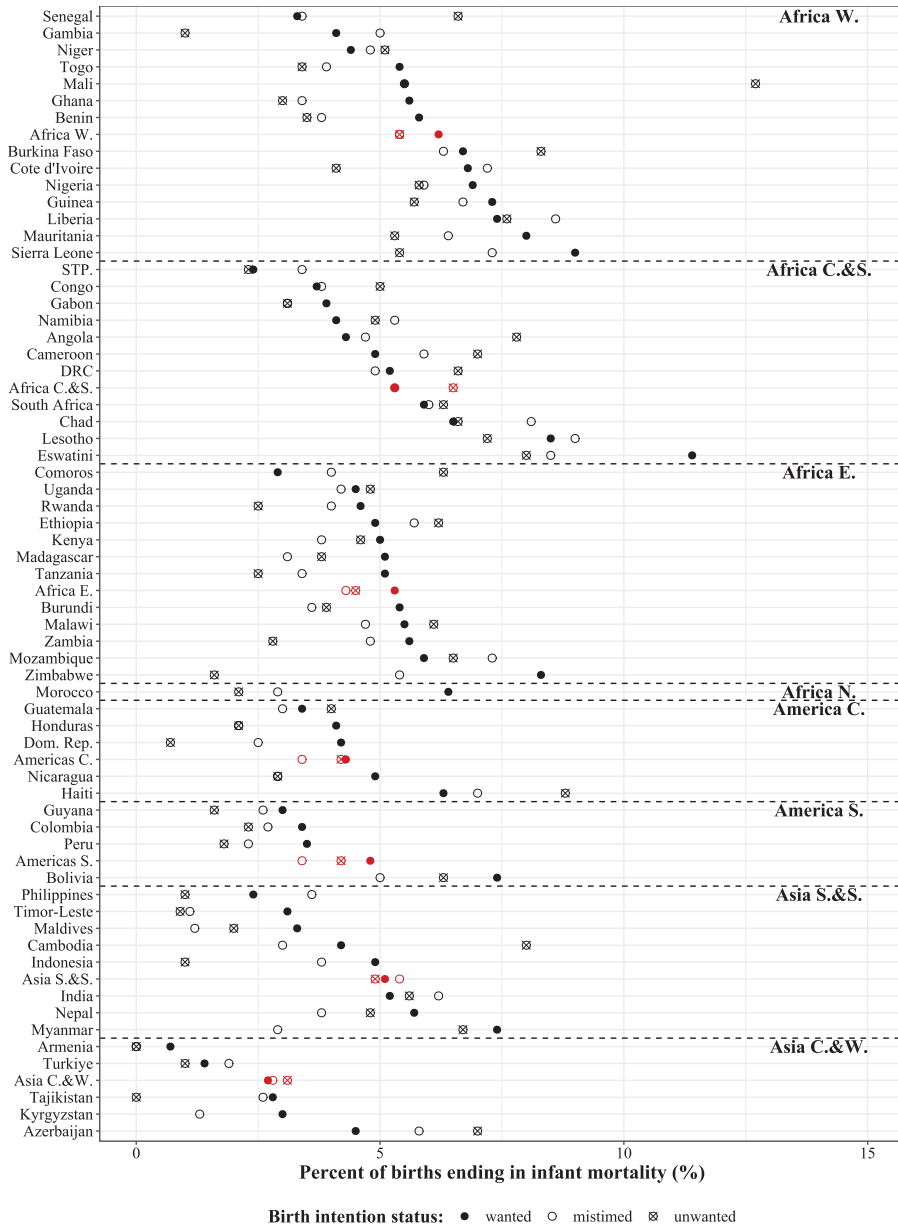
Sibling fixed effects

Figures 3–5 show predicted probabilities of infant mortality by birth intention status and world region or country calculated based on our fixed-effects linear probability models holding a woman's age at the time of birth, the child's birth order, and sex at their means. Online Appendix Table A2 shows the regression estimates of the model for birth intention status. Before running these final models, we included the control variables separately first starting from a model with birth intention status and mother-fixed effect only, then adding the mother's age at birth, the birth order of the child, and finally the child's sex, respectively (the simplest model is shown in Online Appendix Table A3, and the rest is available on request). The differences between unintended (unwanted/mistimed) and wanted pregnancies generally became more pronounced as variables were added. This finding suggests that the control variables might work in the opposite direction to birth intention status in predicting infant mortality.

Figure 3 shows that once all time-invariant maternal variation was controlled for in our models, in all regions the predicted probability of infant mortality was the lowest for wanted births. However, among unplanned births, the direction of the association varied. Unwanted pregnancies had the highest predicted probabilities of infant mortality of all birth intentions status categories in Central and Southern Americas, Central and Western Asia, and Central, Southern, and East Africa, whereas in West Africa as well as South and Southeast Asia this was the case for mistimed pregnancies. The lowest predicted probability for infant mortality was observed among wanted births in Central and West Asia (2.5 percent) and the highest for mistimed pregnancies in West Africa (10.8 percent) and South and Southeast Asia (10.7 percent).

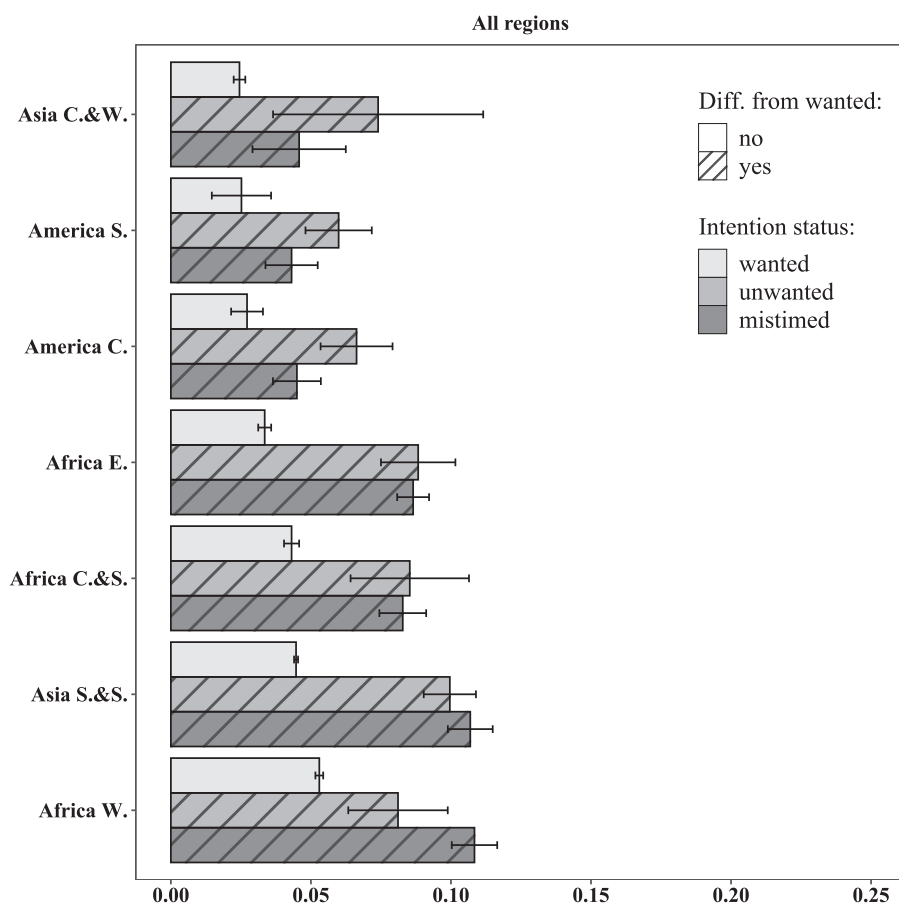
The picture gets more nuanced when individual countries are examined, both when considering the magnitude of the associations and their

FIGURE 2 Infant mortality by birth intention status in each country and by region, ordered by infant mortality of wanted births within each region



NOTE: The value for Kyrgyzstan for unwanted births was beyond the plot scale and was excluded (51.5 percent). Regional values are governed by the applicable Creative Commons License.

FIGURE 3 Predicted probability of infant mortality by birth intention status and world region. Predicted probabilities with 95 percent confidence intervals

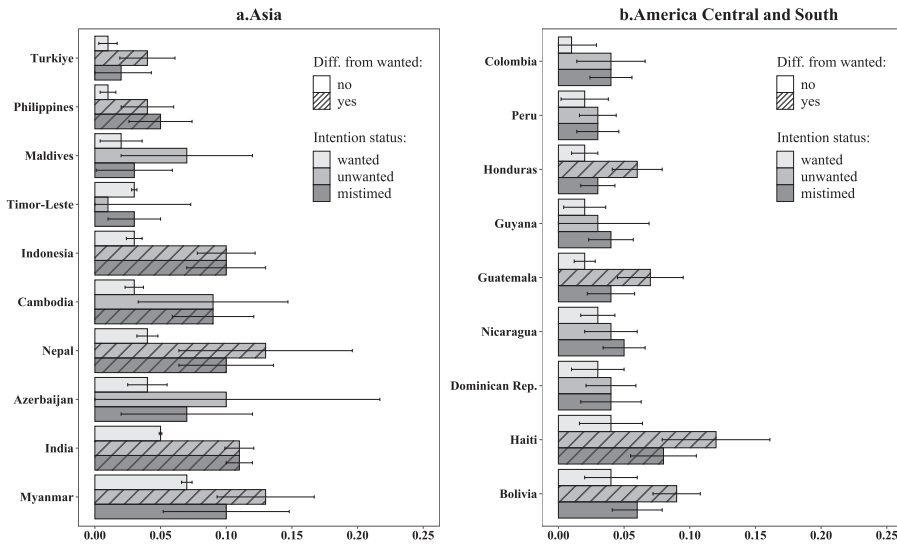


NOTES: Mother's age, birth order, and child's sex fixed at means. Statistical significance based on the *p*-values from the models. Ordered by the probability of infant mortality for wanted pregnancies. C = Central; E = East; S = South(ern); W = West; S & S = South and Southeast. (See Online Appendix Table A2 for full results).

statistical significance (Figures 4 and 5). Out of the 57 countries retained in the country-level regression models,⁴ in 17 countries both mistimed and unwanted births had a higher predicted probability of infant mortality than wanted births, whereas in 18 countries only mistimed pregnancies were significantly different, in six countries unwanted only, and in 16 countries neither.

Overall, the predicted probabilities for unwanted and mistimed pregnancies in individual countries were primarily below 0.10 in Central and South America, while the highest values were mainly found in the African countries (Figures 4 and 5; see Online Appendix Table A2 for regression coefficients). When it comes to statistical significance, in Central and West

FIGURE 4 Predicted probability of infant mortality by birth intention status and country in Asia and the Americas. Predicted probabilities with 95 percent confidence intervals



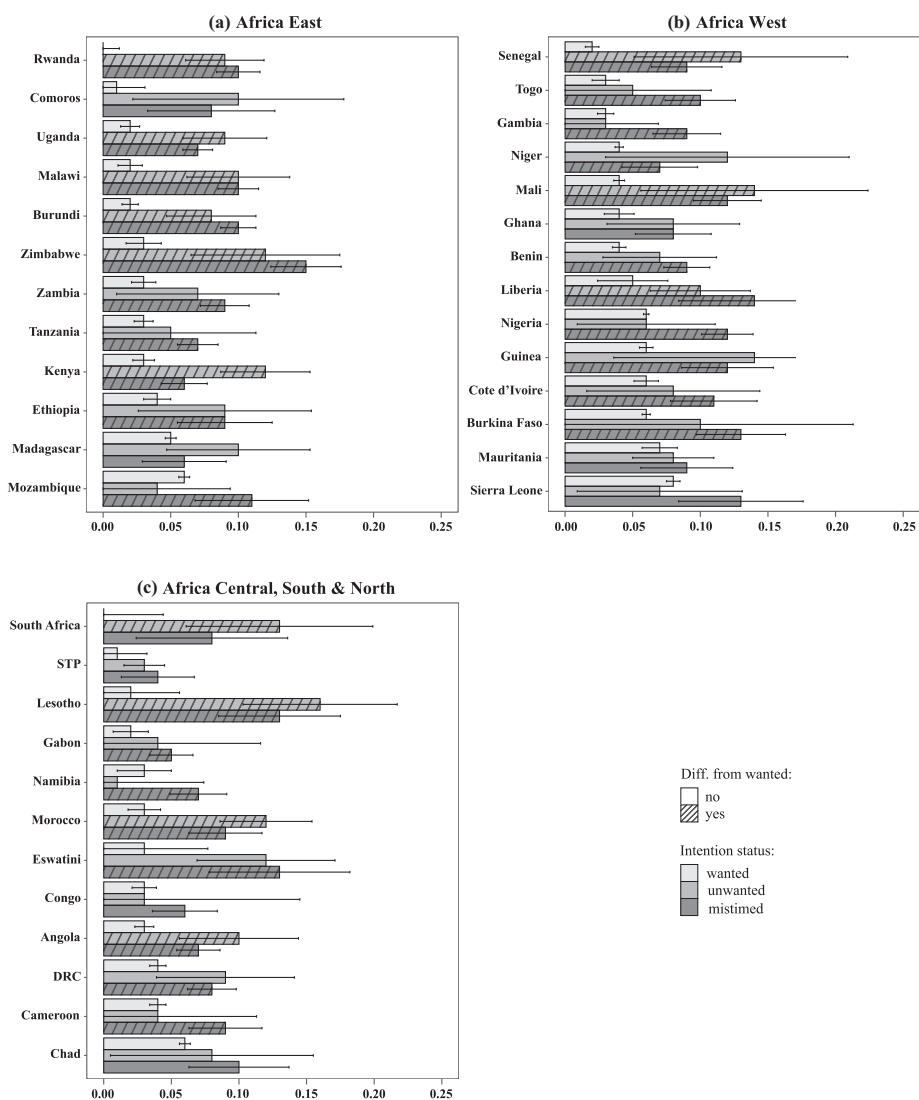
NOTES: Mother's age, birth order, and child's sex fixed at means. Statistical significance based on the *p*-values from the models. Ordered by the probability of infant mortality for wanted pregnancies. Armenia, Kyrgyzstan, and Tajikistan dropped from country-level analysis (but retained in the region-level in Figure 3) due to a low number of unintended pregnancies reported. (See Online Appendix Table A2 for full results).

Asia mistimed and unwanted pregnancies did not differ from wanted ones in Azerbaijan, but the predicted probability of infant mortality was higher for unwanted than wanted births in Türkiye. In South and Southeast Asia, the picture was more varied: in four countries both unwanted and mistimed births had a higher predicted probability of infant mortality than wanted births (India, Indonesia, Nepal, and the Philippines), in two no differences were found (the Maldives and Timor-Leste), and in one each either unwanted (Myanmar) or mistimed pregnancies (Cambodia) differed from wanted ones (Figure 4, panel a).

In the Americas, in many countries (Colombia, Dominican Republic, Guyana, Nicaragua, and Peru) predicted probability of infant mortality did not differ by birth intention status. However, the lack of significant results could be due to small samples, as in these countries infant mortality was reported in less than 100 cases (except for Nicaragua). In Bolivia, Guatemala, and Honduras, infant mortality was more likely among unwanted births, and in Haiti among both unwanted and mistimed births, with a relatively large, predicted probability of above 0.10 for unwanted births (Figure 4, panel b).

In West Africa, the predicted probability of infant mortality was often higher for mistimed births than wanted ones, but no difference was detected between wanted and unwanted births in most countries. This pat-

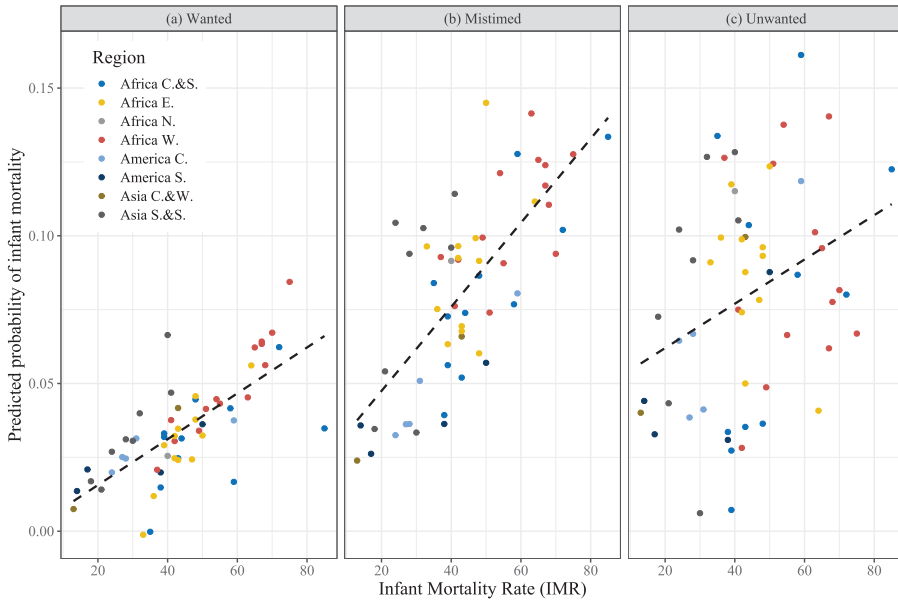
FIGURE 5 Predicted probability of infant mortality by birth intention status and country in Africa. Predicted probabilities with 95 percent confidence intervals



NOTES: Mother's age, birth order, and child's sex fixed at means. Statistical significance based on the *p*-values from the models. Ordered by the probability of infant mortality for wanted pregnancies. DRC, Democratic Republic of Congo; STP, Sao Tome and Principe. (See Online Appendix Table A2 for full results).

tern was also found for nine countries in other regions of the continent. In most of the remaining African countries, both unwanted and mistimed births were significantly different from wanted ones, with the predicted probability reaching almost 0.15 for unwanted births in South Africa and Lesotho. The very high predicted probabilities of infant mortality in these

FIGURE 6 Predicted probability of infant mortality by infant mortality rate of each country, results from fixed effects models. C = Central; E = East; S = South(ern); W = West; S & S = South and Southeast. Linear fit (dashed black lines)

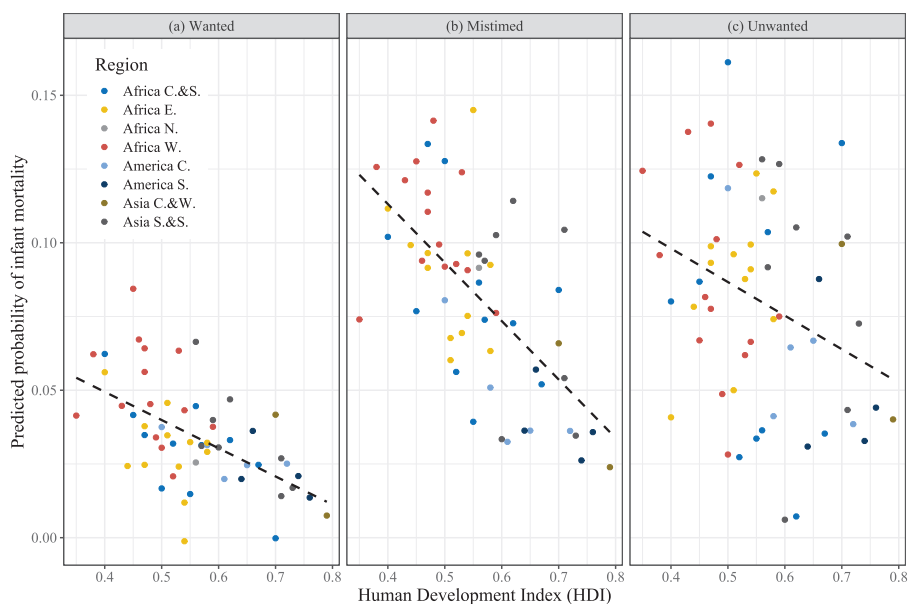


two countries are in line with the findings of Flatø (2018) who identified the largest share of IMR attributable to undesiredness in sub-Saharan Africa to be in the southern part of the continent. The exceptions to the pattern of association found in most African countries were Chad, Comoros, Congo (Brazzaville), Ghana, Madagascar, Mauritania, Sao Tome and Principe, and Sierra Leone, where no differences in infant mortality by birth intention status were found (Figure 5). In some countries, the small number of infant deaths could be behind the lack of statistically significant association (Comoros, Sao Tome and Principe). However, despite relatively few cases of infant deaths in some other countries (e.g., Lesotho and Namibia), the elevated predicted probability associated with unwanted and/or mistimed births is still clearly visible.

Contextual factors

We examined whether the association between birth intention status and infant mortality varied by contextual characteristics of interest: IMR (Figure 6) and HDI (Figure 7). We show results for all countries, including the linear fit, and the color-coded points by region. In line with results from the previous section, predicted probabilities of infant mortality are generally higher for mistimed and unwanted births, as compared to wanted ones

FIGURE 7 Predicted probability of infant mortality by human development index (HDI) of each country, results from fixed effects models. C = Central; E = East; S = South(ern); W = West; S & S = South and Southeast. Linear fit (dashed black lines)



(Figures 6 and 7). The predicted probability of infant mortality increases with countries' IMR (Figure 6) and decreases with countries' HDI (Figure 7). These relationships are visible across all birth intention status groups, but they are the strongest for mistimed births (the steepest slope). These results suggest a particularly heavy mortality burden associated with mistimed pregnancies, which is magnified in the contexts characterized by high early mortality and low HDI. Overall, children born following mistimed and unwanted pregnancies are disadvantaged when it comes to survival, and for mistimed births, this disadvantage is even larger in less "developed" settings.

Sensitivity analyses

We ran sensitivity analyses to ensure the robustness of our results. First, we examined whether the length of the preceding birth interval (and its quadratic effect) might explain our results, especially pertaining to mistimed pregnancies, which are more likely to take place after a short interval. This is important as short birth intervals are associated with a higher risk of infant mortality (Molitoris, Barclay, and Kolk 2019). The results are not fully comparable to those presented in Figures 3–5 and Online Appendix Table A2 since we had to restrict the sample to only those women who had at least three births (to retain at least two birth intervals, as done by

Molitoris, Barclay, and Kolk 2019). We were able to retain 79 percent of the births of our analytic sample.

The point estimates were very similar in both models (with and without birth intervals) suggesting our results were not mainly explained by birth intervals. However, significance levels changed: 25 instead of 41 nations now had significant effects (compare Online Appendix Tables A2 and A4). These changes in statistical significance are likely partly due to the decline in sample size in the birth interval analysis and partly due to the birth interval explaining a proportion of the associations we initially found. Moreover, there is undoubtedly an overlap in what the birth interval and mistimed variables measure, as mistimed births are those that happened earlier than expected, meaning that their birth intervals were likely shorter. Nevertheless, since the birth interval sensitivity analysis provided similar results as the original model and since our original model was able to include a larger and more diverse sample, we retained it as the main one. The sensitivity analysis highlights that birth intervals alone cannot explain our results. This provides strong evidence that birth intendedness does matter in addition to birth spacing.

Next, we ran the same analysis as shown in Figures 3–5 and Online Appendix Table A2, but only including births that took place at least a year before the interview date (Online Appendix Table A5). We were able to include 79 percent of the births from our analytic sample in this analysis. The point estimates (see Online Appendix Table A5) were very similar to those presented in our main model (Online Appendix Table A2). This result is not unexpected because infant mortality tends to be concentrated in the first few days and weeks of life (Preston, Heuveline, and Guillot 2001) and thus the shorter exposure of more recent births only has a minimal impact on the results. This was confirmed in the analysis where the outcome was neonatal mortality, which suffers less from censoring than infant mortality. These results were similar to the main model, but the effect sizes were smaller in some cases (Online Appendix Table A6). In terms of significance, there were 21 countries with no significant effects by birth intention in the more restrictive model (Online Appendix Table A5) and 24 in the neonatal mortality analysis (Online Appendix Table A6), compared to 16 in the original model. This could be due to a loss of statistical power, the more restrictive analytic sample, or outcome variable only taking into account deaths within the first month after birth, respectively.

Finally, we tested for interactions between birth intention status and the other explanatory variables, as well as nonlinear effects for age and birth order first using step functions (one-year or one-child intervals). The results suggested linear or at most quadratic effects, so we settled for second-order polynomial effects (not shown, available on request). The polynomial effects were rarely significant (in five countries for age; and 12 countries for birth order), and neither were the interactions with birth intention status

(in three countries for age and four for birth intention status) (not shown, available on request). The point estimates for birth intention status including a polynomial effect for age and birth order (not shown, available on request) were very similar to the estimates for birth intention status shown in Online Appendix Table A2. As such, we chose the simpler model with linear effects and no interactions.

Discussion

To the best of our knowledge, this is the first large-scale cross-country comparative study in several world regions to analyze the effect of pregnancy intention status on infant mortality while controlling for all time-invariant maternal characteristics. Most previous studies controlling for such factors have focused on a single nation, India being the most popular choice. Furthermore, unlike most previous studies using similar methodologies (except for Singh et al. 2012, which used fixed effects in the context of India), we differentiate between mistimed and unwanted pregnancies rather than analyzing them as one group.

Our modeling strategy removes all time-invariant maternal variation from the model. Thus, we show that among children born to the same mother, those born as a result of an unintended pregnancy tend to fare worse even when it comes to an extreme outcome like mortality. This is the case, especially in contexts where overall infant mortality levels are higher and “development” levels lower. Thus, people seem to be better able to take care of children when they are ready to have them. When mothers do give birth at a point when they do not want to, infants’ survival chances are higher in contexts with overall better social, economic, and health conditions.

Birth intentions matter when controlling for unobserved characteristics

Our results highlight the importance of accounting for time-invariant maternal characteristics when studying the relationship between pregnancy intentions and early mortality. While the bivariate analyses indicated unintended pregnancies were often associated with lower infant mortality than wanted pregnancies (except for most West African countries), the fixed-effects results differed. In none of the countries did the analysis accounting for unobserved heterogeneity indicate that mistimed or unwanted pregnancies had a statistically significantly lower probability of infant mortality than wanted pregnancies. On the contrary, in 41 countries out of the 57 retained in the regression analyses, a higher probability of infant mortality was found for at least one category of unintended pregnancy compared to wanted pregnancies.

These findings are consistent with the results of studies that employed fixed-effect models in India and Bangladesh, where mortality risk also increased for unintended births (Chalasan, Casterline, and Koenig 2007; Singh et al. 2012), and a study on sub-Saharan Africa showing mortality disadvantage of children who exceeded women's ideal family size (Flatø 2018). This may be due to mechanisms described in the Conceptual Framework section, including behaviors during pregnancy and the postpartum period, which may not be optimal for infant health.

Mistimed and unwanted births differ

Previous studies that employed fixed-effect models and separated mistimed and unwanted pregnancies found similar associations for both unwanted and mistimed pregnancies. In India (Singh et al. 2012), mistimed and unwanted pregnancies carried a similarly elevated early-mortality burden, as compared to wanted births. While our study corroborated the findings for India, we identified that in some countries the association with infant mortality differed between unwanted and mistimed births. In Asia and the Americas, in case of a statistically significant association, these were either both mistimed and unwanted or mainly unwanted births that had an elevated mortality risk. The stronger association for unwanted than mistimed births in some countries can be seen as in line with studies on other health outcomes. For example, it has been highlighted that unwanted births may be more likely preterm and have lower weight than mistimed ones (D'Angelo et al. 2004; Kost and Lindberg 2015). Since both conditions are known factors for early mortality (Katz et al. 2013), this may be one of the channels through which unwanted births result in the highest mortality risk in some countries. Future studies could explore these pathways in nations covered by this study.

Interestingly, we also found that in Africa and its Western part in particular, mistimed births were associated with a higher risk of infant mortality in a larger number of countries than unwanted births. These results cast new light on the variation in the consequences of pregnancy intentions and have implications for the design of future studies on the topic. Our results suggest that in some African countries, becoming pregnant too early may be equally or more disruptive than becoming pregnant when a woman reports not wanting to have any (more) children. This is important given that our findings on mistimed pregnancies are more prevalent than unwanted ones across virtually all African countries. There are several reasons why this may be the case.

It has been shown that, compared to other regions such as Asia or Latin America, women in many African countries tend to have higher family size ideals (Bongaarts and Casterline 2013) as well as a higher unmet need for contraception for spacing births (Sedgh, Ashford, and Hussain 2016).

Moreover, the latter report suggests that the unmet need for spacing across African countries is higher than that for limiting, which constitutes a reversal of the pattern observed in Asia and Latin America. This is in line with research suggesting that the African fertility transition may be distinct from that in other world regions in being driven mainly by birth postponement rather than fertility limitation (Moultrie, Sayi, and Timæus 2012). The authors suggest that the limitation of family size is not a primary consideration in the family formation strategies of women.

This is in line with anthropological work on reproduction in West Africa (Bledsoe 2002) and with Johnson-Hanks (2007) who notes that “African women who do not desire to limit the number of children they bear nonetheless exert considerable conscious effort in organizing and administering their reproductive careers, and this organization has demographic consequences” (Johnson-Hanks 2007, 1002). The author suggests that the key objects of reproductive management may go beyond the number of children and that in Africa spacing is more important than stopping. The described uniqueness of African countries with respect to patterns of spacing and stopping and the importance of birth postponement rather than limitation is likely behind the higher levels of mistimed than unwanted births and a stronger association of mistimed pregnancies with infant mortality. However, it should also be acknowledged that the fact that there are more mistimed than unwanted births across the continent increases the statistical power of the former category.

Overall, the intentions people have may vary substantially from one society to another, and the simplistic measures, as collected in surveys, have only a limited power in describing this complexity. The heterogeneity in the strength of the associations we found across the world regions could be reflecting the fact that the crudely defined categories pertaining to mistimed or unwanted pregnancies may be more or less relevant in one setting compared to another. Despite the limitations of available retrospective measures in surveys, by distinguishing between the more detailed categories of pregnancy intentions we can bring some of these issues into light. For example, our study identifies one more dimension related to reproductive behavior in which many African countries may differ compared to other world regions. Moreover, the variability in the association between birth intentions and child outcomes that we identified can inform programmatic priorities. For example, in settings where mistimed pregnancies carry the highest early mortality burden, focusing on programs that identify obstacles to delaying pregnancy could be one of the ways to address high levels of infant mortality. When it comes to measurement issues, our results suggest that when studying the consequences of unintended pregnancies in African countries it is critical to consider not only births that exceeded the desired family size, as done in previous research (Flatø 2018) but also take into account the

fact that pregnancies at lower parities may be mistimed or unwanted and associated with a high risk of adverse outcomes.

Overall, our study uncovers new patterns of variation in the association between pregnancy intentions and infant mortality globally and contributes to the body of research highlighting the importance of considering both mistimed and unwanted pregnancies.

The importance of birth intention status varies by context

Overall, our results highlight that the relationships between pregnancy intentions and infant mortality found in one setting are not necessarily generalizable to other contexts and underscore a need for more cross-country comparative studies. Even though we documented the negative effects of unwanted and/or mistimed pregnancies in many countries, there were 16 countries with no association between birth intention status and infant mortality.⁵ Future studies could focus on policy analyses and more detailed contextual examination of these countries compared to those where an effect was found. This could potentially reveal what distinguishes contexts where no link between unintended pregnancy and infant mortality exists, for example in terms of access to health services, contraception, antenatal, and postnatal care, or contraceptive desires and practices. Such investigations could deliver policy-relevant information on how to break the link between unintended pregnancies and higher infant mortality.

Regarding contextual factors, we show that these are correlated with the relationship between birth intention status and infant mortality. Specifically, in settings with low levels of “development,” which we proxied with IMR and HDI, children born as a result of unintended, and most notably, mistimed pregnancy, are at a higher risk of early mortality. Thus, in these settings, the association between unintended pregnancies and child survival is more pronounced. It is possible that as social, economic, and health conditions improve, it may be easier for women to deal with the difficulties arising from becoming pregnant and giving birth at a time when they are not ready for it. In contexts with higher development levels and better overall health conditions, women and children are likely to benefit from greater availability of medical care, both in the pre- and post-natal period, thus mitigating the negative consequences of unintended pregnancy. For example, in poorer settings and contexts where the overall burden of early mortality is high, access to healthcare services is likely to be more limited. Thus, it may be particularly difficult for women who become pregnant at the time that they did not plan to mobilize resources to receive timely (or any) antenatal care or get in contact with skilled health personnel. This is critical not only for fetal health and early identification and management of pregnancy complications but also for receiving trained assistance at delivery, all of which are key for early-life survival. Beyond health conditions, HDI prox-

ies the overall population's standard of living and knowledge (with income and educational level, respectively). Such type of better overall social and economic conditions as well as the availability of wider social safety net and services—characteristic of countries with higher development levels—may weaken the association between unintended childbearing and early mortality by serving as a buffer against challenging circumstances (related to financial resources, care time, or psychological strain) brought about by an unexpected pregnancy.

Strengths, limitations, and directions for future research

The main strengths of this study involve the examination of the effects of pregnancy intentions on infant mortality in a large-scale cross-country and cross-region comparative setting while controlling for time-invariant maternal factors associated with both infant mortality and pregnancy intentions, paying particular attention to the variation between mistimed and unwanted births, and casting light on the relevance of context and contextual factors.

The limitations of the study are closely related to data and measurement. First, the sample sizes in some of the individual countries were relatively small, which compromised the statistical power of these country-specific analyses, as mentioned in the Results section. Second, as discussed earlier, retrospective measures of pregnancy intentions may suffer from ex post rationalization and recall bias. As we discussed in detail in the section on the measurement of pregnancy and birth intentions, this may be a particular issue for children who later died (see Smith-Greenaway and Sennott 2016). However, given that women tend to be less likely to report these births as unwanted, our estimates are likely to be conservative and understate the actual differences in the outcome. Third, while our analytic strategy was able to account for any time-invariant unobserved maternal characteristics, there may be unobserved time-variant characteristics that we were not able to control for. One example could be the selection into which unintended pregnancies are aborted rather than carried to term (Bishai et al. 2015; Väisänen and Batyra 2022). Other factors that our analytical strategy does not account for are changes related to household characteristics and women's partnership status. This needs to be kept in mind, although it should also be noted that our analysis focuses on births close to the survey date. This feature of our study design increases the chances that the household and partnership context, within which each of the children is born, is similar. Next, simulations of sibling fixed-effects models examining the effect of reproductive factors on child mortality have shown that the effects might be biased because child mortality affects fertility behavior (Kravdal 2020). While the paper did not examine this bias in relation to pregnancy intentions specifically, one has to keep in mind the limitations

of the model used. However, as also highlighted by Kravdal (2020), a naïve regression model gives even more biased results and it is not easy to solve the issue by adding control variables or changing the modeling strategy. Thus, our methodological approach, even if imperfect, allows us to add to the current knowledge about the effects of pregnancy intentions, as it overcomes many of the caveats of previous research, as explained throughout the paper. Overall, our analytic strategy controls for a large part of the selection that most previous studies did not. Finally, due to the fixed-effects design, the results are not generalizable to those women who did not have two births in the five years preceding the survey. However, as shown earlier, this group is similar to those with at least one birth within the last five years.

When it comes to directions for future research, it would be relevant to investigate using the methodology applied in this paper and in a cross-country perspective, whether and where pregnancy intentions matter for other outcomes related to children's as well as the mother's well-being. While in this study we focused solely on infant mortality, not least because of the salience of this outcome and availability of comparable data for the largest number of countries possible, it would be equally relevant to investigate impacts on children's health later in life as well as maternal outcomes where the necessary data exist. Moreover, while our analysis was confined to two general and widely available measures to describe the context, future studies could explore other and more detailed contextual dimensions and, apart from between-country analysis, conduct within-country examinations that could help explain variation in these associations.

Conclusions

We show children born to the same mother have an increased risk of infant mortality if the pregnancy was unintended. However, the strength of the association and the type of intention (unwanted or mistimed) that matters the most depends on context. These results were robust to various sensitivity analyses. Overall, these effects were more pronounced in contexts with higher IMRs and lower levels of "development." This highlights the importance of conducting the analyses at the very least on the country level rather than by region to better understand contextual differences. It is equally important to separate between unwanted and mistimed births as they have different associations with infant mortality depending on context.

Acknowledgment

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Notes

1 While studies have theorized about how the levels of unintended pregnancies, unmet need for contraception and countries' level of development interact (e.g., Bongaarts 2014; Cleland, Harbison, and Shah 2014), to the best of our knowledge, there are no theories on the relationship between development level and *consequences* of unintended pregnancies such as infant/child mortality, which we could have applied in our study.

2 We use DHS regions, as they typically include countries geographically and culturally relatively similar to each other. However, as some regions only included a small number of countries, we combined them into larger groups than the original DHS regions: Central and Southern Africa; South and Southeast Asia; Central and Western Asia were grouped into three groups, respectively, instead of six. While only one country from North Africa was included (Morocco), we did not group it with other regions due to lack of a sufficiently similar group of countries.

3 Due to our modeling strategy, we had to limit our analytic sample to those who had given birth twice within five years and who reported a birth intention status for at least two births. Thus, the model is not generalizable to all mothers. While we could have overcome the issue of censoring by only including children who were born at least 12 months before the survey, the generalisability of the results would have been fur-

ther limited. We thus decided to maximise generalisability, while conducting sensitivity analyses showing the results did not change importantly due to this decision. As infant deaths typically take place in the first weeks and months of life, we capture most deaths even though some censoring remains in the model. Had we used the more restrictive analytic sample, it would have included a disproportionate number of short birth intervals, which is associated with higher infant mortality (Molitoris et al. 2019), and thus could have affected our results. Indeed, the regression estimates often were more extreme in the more restrictive sample. Therefore, the estimates presented in our main model are conservative. Any changes in the statistical significance were limited to cases where the *p*-value had already been close to 0.05 in the main model.

4 Armenia, Kyrgyzstan, and Tajikistan were not included at country-level due to the small number of unintended births observed, although they were retained in the regional analyses above.

5 These were Comoros and Madagascar in East Africa; Ghana, Sierra Leone, and Mauritania in West Africa; Chad, Congo, and Sao Tome and Principe in Central/Southern Africa; Nicaragua, Dominican Republic, Peru, Guyana, and Colombia in the Americas; and Azerbaijan, Timor-Leste, and Maldives in Asia.

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