Ethnicity and maternal and child health outcomes and service coverage in western China: a systematic review and meta-analysis

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Summary
Background There is a dearth of accurate information about health outcomes and health service coverage among ethnic minorities in China. We assessed maternal and child health (MCH) outcomes and service coverage among ethnic minorities compared with Han populations in western China.

Methods We did a systematic review searching English (Embase, MEDLINE, Web of Science) and Chinese (China National Knowledge Infrastructure [CNKI], VIP, Wanfang) databases for population-based studies comparing MCH indicators between ethnic minorities between Jan 1, 1990, and Nov 9, 2016, in any language. For studies making individual comparisons we used the odds ratio (OR) and corresponding 95% CIs as the primary measure to assess the association between MCH indicators and ethnicity. We used a random-effects model to pool odds ratios.

Findings We included 29 Chinese and 16 English language studies, providing 31 individual comparisons and 15 ecological comparisons. Ethnic minority women had lower odds of antenatal care use (pooled crude OR 0·60 [95% CI 0·48–0·75]) and birth in health facilities (0·50 [0·39–0·64]) than did Han women; and their children had higher odds of mortality (2·02 [1·23–3·32]) and lower immunisation (0·34 [0·24–0·47]) than did Han children. After taking account of the potential confounding effects of socioeconomic factors, ethnic minority women were less likely to use antenatal care (pooled adjusted OR 0·54 [0·42–0·75]) or to immunise their children (0·34 [0·24–0·47]) compared with Han women.

Interpretation China has a wealth of primary data that could further our understanding of why ethnic minority populations are lagging behind. As MCH outcomes continue to improve nationally, ethnic minorities will take a greater share of the overall burden of adverse outcomes, requiring strategic investments to address the specific challenges faced by people living in remote areas.

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have been less stringent for people living in autonomous regions and many ethnic minority couples were allowed a second or third child under the one child policy.\(^7\) In education, some minority students have benefited from subsidies and preferential admittance into colleges and universities, and bilingual education has been offered to ethnic groups with a language and writing system.

Despite an increasing focus on ethnic minority culture and identity in China, there is a dearth of accurate demographic, health outcome, and health service coverage data for ethnic minorities. An international review bringing together experts in indigenous health data systems from across the world reported only two studies from China, one from Tibet and one from the Dai minority group in Yunnan Province.\(^1\) Similarly, a literature review examining socioeconomic variation in maternal health care and maternal mortality in China found three studies showing lower uptake of antenatal and delivery care among ethnic minority populations, but no studies reporting on maternal mortality.\(^9\)

Repeated calls have been made to improve the variation in MCH outcomes and service coverage for ethnic minorities.\(^1\) In Chinese papers, questions were referred to the senior author (CR), who made a final decision. We obtained full text copies of potentially relevant articles and the reference lists were searched for further relevant publications.

Studies were eligible for inclusion if they compared MCH indicators between Han populations and ethnic minorities, or between particular ethnic minorities in western China. Western China consists of 12 provinces: Tibet, Qinghai, Gansu, Shaanxi, Sichuan, Guizhou, Guangxi, Yunnan, Chongqing, Ningxia, and Inner Mongolia. We included studies reporting data from 1990 onwards to coincide with the Millennium Development Goals. Both facility-based studies and any studies that did not sample from western China were excluded. MCH indicators included neonatal, infant, child or maternal mortality and MCH service coverage, specifically antenatal visits (≥1, ≥3, ≥5, and first visit in first trimester), birth in hospital, caesarean section, and one of the five traditional childhood vaccines (Bacillus Calmette–Guérin [BCG], oral polio vaccine [OPV], diphtheria, tetanus, and pertussis [DTP], measles vaccine [MV], and hepatitis B vaccine [hepatitis B]).

We included two types of studies: (1) studies comparing individual ethnicities and (2) studies making ecological comparisons between geographically defined groups. Studies making individual comparisons were included if the paper reported crude, adjusted, or both odds ratios (ORs) with 95% CIs comparing individuals with different ethnic affiliations (ie, Han compared with ethnic minorities or comparisons between ethnic minorities); or if the paper provided the data that allowed us to calculate these effect estimates with 95% CIs. Ethnic groups with a sample size of less than 30 were excluded from the analysis. For ecological studies we included papers that made comparisons between prefectures, counties, or villages with a stated ethnic composition. Studies comparing autonomous prefectures, counties, or villages without stating the ethnic composition were excluded, as were studies comparing autonomous provinces. Ecological studies were included regardless of the statistical methods used to compare the geographically defined groups.

Data for study location, dates, design and population, sample size, definition, and ascertainment of MCH indicators and ethnic groups, the type of denominator and the numerator for each indicator were extracted by five authors (DS, LP, FT, YH, and CR). Study populations described in more than one paper were included only once, using data from the paper with the most detailed information. When more than one MCH indicator was assessed in a single study, these were extracted and treated as separate datasets.

The risk of bias for each dataset was assessed using the component approach adopted by the Cochrane Collaboration.\(^8\) All datasets were assessed on the rigour of the study design (eg, whether the sampling strategy for a cross-sectional survey was clearly described and data sources stated), the completeness of data, the definition and ascertainment of the MCH indicator, the definition of

**Methods**

**Search strategy and selection criteria**

We searched English (Embase, MEDLINE, Web of Science) and Chinese (China National Knowledge Infrastructure [CNKI], VIP, Wanfang) databases between Jan 1, 1990, and Nov 9, 2016, using the search terms “health care utilisation”, “ethnic minorities”, and “western China” (see appendix pp 1–8 for the full search strategy). We only included papers published in peer-reviewed journals, but there were no language restrictions. All English titles and abstracts were reviewed by one author (DS); the Chinese titles and abstracts were reviewed by two authors (LP, FT). The two Chinese authors read all titles and abstracts independently, and agreed the final selection of papers. Whenever the Chinese authors disagreed or were uncertain, they consulted one of the authors (DS) for clarification. Where uncertainty persisted for English or Chinese papers, questions were referred to the senior
ethnicity, the statistical analysis (eg, whether survey design had been accounted for in the analysis), and adjustment for confounding. Each of the quality criteria were classified as having a low risk or high risk of bias for each dataset.

For example, a dataset was classified as having a high risk of bias for study design if a cross-sectional survey was said to be based on “stratified multistage random sampling” but no further details were given. Similarly, cross-sectional surveys reportedly using random sampling but without information about the data from which children were sampled were considered at high risk of bias for study design. Where there was insufficient information to assess the risk of bias, the dataset was classified as at an unclear risk of generating bias.

Data analysis

All meta-analyses were carried out using Stata 14.0. The association between ethnicity and each MCH indicator was estimated using ORs and 95% CIs. Both the crude ORs (either provided in the paper or calculated by us) and the adjusted estimates were included, but pooled separately for each MCH indicator. If a study provided findings from several time periods, only the effect estimates from the latest period were included. The weighted summary measure of effect for each MCH indicator was obtained by conducting a random-effects model and represented with a forest plot. The presence of statistical heterogeneity across studies was assessed by applying an I² value (<25% interpreted as no heterogeneity, 25–49% as low heterogeneity, 50–74% as moderate heterogeneity, and ≥75% as high heterogeneity) and a χ² test with a threshold p value of 0.10 to determine significance. We used funnels plots and Begg’s test to determine significance) to assess if there was any potential publication bias. Additionally, sensitivity analyses and meta-regressions were done to assess the effect of calendar effect and small-study bias on the pooled results. We used year of publication rather than year of data collection to test for calendar effect because some studies did not report the latter. This review was reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

Role of the funding source

The funder of the study had no role in the study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

The Chinese search initially identified 4335 titles and abstracts; 158 of these were retained for full text review and 129 were excluded because they did not contain...
relevant data (figure 1). The English search identified 4082 titles and abstracts; 131 of these were retained for review and 115 were subsequently excluded. 29 Chinese language studies and 16 English language studies, providing 31 individual comparisons and 15 ecological comparisons, were included.

Table 1 describes the 31 eligible studies based on individual comparisons. 19 studies reported on maternal health indicators (two maternal mortality, 11 antenatal care, ten facility births, and one caesarean section) and 13 on child health indicators (three child mortality, one infant mortality, one neonatal mortality, and ten vaccination). One study reported on both maternal and child health indicators. Most studies described data collected during 2000–09, and the most commonly represented provinces were Guizhou (n=12), Ningxia (n=7), and Xinjiang (n=7). Most studies (n=28 [90%]) relied on data from cross-sectional surveys, and the most commonly reported comparisons were between Han Chinese and other (n=25), Hui (n=9), Zhang (n=6), or Uyghur (n=6) ethnic groups.

Only four studies were judged to be at low risk of bias across all of the quality criteria (table 2). Sampling strategies for cross-sectional surveys were generally well described, but only half (17 of 31) reported the data sources from which the sample was drawn. Only ten of 31 studies provided data for response rates and 16 of 31 studies reported the definition of outcomes. For the ten studies reporting immunisation coverage, the source of information varied: four studies relied on mother’s report only, one on blood tests only, and five on at least two sources (mother’s report, household certificate, health facility card, blood tests, or immunisation scars). Most (21 of 31) studies used logistic regression, but it was not always clear whether adjustment for survey design had been taken into account in the analysis. Two studies reported regression analyses but data could not be used because the ethnicity was treated as a continuous variable. 17 studies adjusted the analysis for confounders, including sociodemographic factors, geographic accessibility, and health-related knowledge.

| Study design (period) | Study setting | Study population | Sample size | Indicators | Ethnic minority: number |
|----------------------|---------------|-----------------|-------------|------------|-------------------------|
| Maternal health      |               |                 |             |            | Han        | Hui       | Uyghur    | Tibetan   | Other ethnicities |
| Lu et al, 2000 (C)   | Cross-sectional survey (1999) | 40 counties in Gansu, Guizhou, Ningxia, Qinghai, and Xinjiang Provinces | Women with a child younger than 3 years | 6069 | Antenatal visits (1st visit in 1st trimester, ≥5), facility birth | 3928 | 759 | 1088 | 321 | .. |
| An et al, 2002 (C)   | Cross-sectional survey (period unclear) | 40 counties in Gansu, Guizhou, Ningxia, Qinghai, and Xinjiang Provinces | Women with a child younger than 3 years | 7152 | Facility birth | 3728 | 751 | 1054 | .. | Other (no name): 1619 |
| Yan et al, 2003 (C)  | Cross-sectional survey (2000) | 24 counties in Xinjiang Uygur Autonomous Province | Women with a child younger than 5 years | 2441 | Facility birth | 461 | 87 | 1392 | .. | Kazak: 381, Mongolian: 45, other (no name): 69 |
| An et al, 2004 (C)   | Cross-sectional survey (period unclear) | 40 counties in Xinjiang, Gansu, Qinghai, Ningxia, and Guizhou Provinces | Women with a child younger than 3 years | 7259 | Antenatal visits (≥3) | 3789 | 762 | 1067 | .. | Other (no name): 1641 |
| Li, 2004 (E)         | Cross-sectional survey (1994) | 51 villages in Diandong County, Yunnan Province | Women who gave birth during 1991–93 | 1062 | Antenatal visits (≥1) | 892 | .. | .. | .. | Other (no name): 170 |
| Fang et al, 2005 (C) | Cross-sectional survey (2001) | China | Women who gave birth in the 3 years before the survey | 1206 | Antenatal visit (≥3) | Not stated | .. | .. | .. | Other (no name): not stated |
| Li et al, 2008 (C)   | Cross-sectional survey (2003) | Guangxi Province Rural women with a livebirth since January 1998 | 407 | Facility birth | 188 | .. | .. | .. | Other (no name): 219 |
| Chang et al, 2009 (C) | Cross-sectional survey (2006) | Tekesi County in Xinjiang Yili Kazak Autonomous Prefecture | Women with a child born in 2000–06 | 862 | Facility birth | .. | 102 | 72 | .. | Kazak: 471, Kyrgyz: 163, other (Han/Mongolian): 51 |

(Table 1 continues on next page)
| Study design (period) | Study setting | Study population | Sample size | Indicators | Ethnic minority: number |
|----------------------|---------------|------------------|-------------|------------|------------------------|
| Cross-sectional survey (2005) | 46 counties in ten western provinces: Gansu, Qinghai, Jiangsu, Sichuan, GuiZhou, Inner Mongolia, Guangxi, Xinjiang, Ningxia, and Chongqing | Rural women with a child younger than 3 years | 13,532 | Antenatal visit (≥1, ≥5, 1st visit in 1st trimester) | Han 8458, Hui 154, Uyghur 149, Tibetan 143, Other ethnicities 5074 |
| Cross-sectional survey (2007) | Five ethnic minority autonomous counties in Guizhou Province | Married women aged 20-49 years | 520 | Antenatal visits (≥1), facility birth | Han 938, Hui 402, Uyghur 119, Tibetan 117, Other (no name): 720 |
| Cross-sectional survey (2007) | 300 rural townships in 10 western provinces | Women aged 15-49 years, who gave birth in the previous year | 2002: 917, 2007: 801 | Antenatal visits (≥1, ≥5, 1st visit in 1st trimester), facility birth | Han 2002: 710, 2007: 424, Hui 10, Uyghur 1, Tibetan 1, Other (no name): 407 (2002) and 377 (2007) |
| Routine data from MCH hospitals and death report cards (1996–2007) | Haibei Tibetan Autonomous Prefecture in Qinghai Province | Livebirths | 44,838 | Maternal mortality ratio | Han 15,000, Hui 10,206, Uyghur 19,632 |
| Cross-sectional survey (2005) | 867 villages in 45 counties in 10 western provinces | Women with a child younger than 1 year | 14,111 | Antenatal visits (≥1), facility birth | Han 9003, Hui 10, Uyghur 1, Tibetan 1, Other (no name): 108 |
| Cross-sectional survey (2006) | Four counties in Ningxia Province | Women with a child younger than 5 years | 553 | Antenatal visits (≥1, ≥5, 1st visit in 1st trimester) | Han 151, Hui 402, Uyghur 1, Tibetan 1, Other (no name): 145 (Yi), 3 |
| Cross-sectional survey (period unclear) | Six ethnic minority counties: Nongchuan and Luxi (Yunnan), Congjiang and Leishan (Guizhou), Hualong (Qinghai), Gongbujiangda (Tibet) | (1) Married women of childbearing age (15–49 years); (2) Guardians of children aged 0-5 years | 455 | Facility birth | Han 122, Hui 10, Uyghur 1, Tibetan 1, Other (no name): 333 |
| Cross-sectional survey (2011) | 12 counties in Tibet Province and Liangshan Prefecture of Sichuan Province | Women with a child younger than 3 years | 1351 | Antenatal visit (≥1, ≥5, 1st visit in 1st trimester) | Han 98, Hui 1, Uyghur 1, Tibetan 1, Other (Zang, Yi, Miao, or others): 1253 |
| Cross-sectional survey (period unclear) | 12 counties in Tibet Province and Liangshan Prefecture of Sichuan Province | Women with a child younger than 3 years | 624 | Caesarean section | Han 77, Hui 1, Uyghur 1, Tibetan 1, Other (no name): 145 (Yi), 3 |
| National maternal and child health reporting system (1996–2009) | Guizhou Province | Livebirths | 1996–2002: 3,481,640; 2003–09: 2,825,212 | Facility births, maternal mortality ratio | Han 1996–2002: 1,806,971; 2003–09: 1,449,734, Hui 1, Uyghur 1, Tibetan 1, Other (no name): 1,674,669 (1996–2002); 1,175,879 (2003–09) |

(Continued on next page)
| Study design (period) | Study setting | Study population | Sample size | Indicators | Ethnic minority: number |
|-----------------------|---------------|------------------|-------------|------------|-------------------------|
| Long, 1996 (C)⁴⁴      | Cross-sectional survey (1992) | Longsheng County in Guangxi Province | Livebirths and under-5 deaths in 1992 | 761 | Mortality of children younger than 5 years | Han | Hui | Uyghur | Tibetan | Other ethnicities |
| Li, 2004 (E)⁴⁴        | Cross-sectional survey (1994) | 51 villages in Diandong County, Yunnan Province | Children born during 1991-93 | 1300 | Child health indicators | Not stated | Han | Hui | Uyghur | Tibetan | Other ethnicities |
| Wei et al, 2005 (C)⁴⁵ | Cross-sectional survey (2003) | Quandongnan Prefecture in Guizhou Province | Children aged 0-2 years | 1377 | Hepatitis B: coverage | 163 | Han | Hui | Uyghur | Tibetan | Other ethnicities |
| Zhou et al, 2007 (C)⁴⁶| Cross-sectional survey (period unclear) | Puding County in Guizhou Province | Children born in 2003 | Full coverage: 213; timely first dose coverage: 169 | Hepatitis B: full and timely first dose coverage | Full coverage: 175; timely first dose coverage: 140 | Han | Hui | Uyghur | Tibetan | Other ethnicities |
| Yang, 2008 (C)⁴⁷      | Routine data from MCH hospitals and death report cards (2003-07) | Yunnan Province | Livebirths | 10 976 | Mortality of children younger than 5 years; infant mortality; neonatal mortality | 2289 | Han | Hui | Uyghur | Tibetan | Other ethnicities |
| Gao et al, 2009 (C)⁴⁷| Routine data from MCH hospitals and death report cards (2003-07) | 10 townships in Mengla County in Yunnan Province | Livebirths and under-5 deaths during 2003-07 | 2003: 1546; 2004: 1577; 2005: 1625; 2006: 1741; 2007: 1903 | Mortality of children younger than 5 years | 2003: 451; 2004: 454; 2005: 453; 2006: 478; 2007: 515 | Han | Hui | Uyghur | Tibetan | Other ethnicities |
| Liang et al, 2009 (E)⁴⁷| Cross-sectional survey (2006) | 160 counties in 31 provinces | Children aged 1-14 years | 40 129 | Hepatitis B: full and timely birth dose coverage | 34 668 | Han | Hui | Uyghur | Tibetan | Other ethnicities |
| Zhou et al, 2009 (E)⁴⁷| Cross-sectional survey (2006) | 16 counties in Guangxi, Guizhou, Tibet, and Shaanxi Province | Children born in 2004 | 3390 | Hepatitis B: timely birth dose coverage and coverage | 1126 | Han | Hui | Uyghur | Tibetan | Other ethnicities |
| Wang et al, 2012 (C)⁴⁷| Cross-sectional survey (2009-10) | Six investigation points within the migrant population area in Urumqi, Xinjiang Province | Migrant children aged 1-4 years old | 341 | Childhood immunisation coverage | 166 | Han | Hui | Uyghur | Tibetan | Other ethnicities |
| Ding et al, 2014 (C)⁴⁷| Cross-sectional survey (2009 and 2012) | Tongxin County in Ningxia Hui Autonomous Province | Children younger than 5 years | 2009: 425; 2012: 479 | Hepatitis B: timely first dose coverage, coverage, number of doses DPT, BCG, OPV, coverage, number of doses, MV coverage | 2009: 55; 2012: 40 | Han | Hui | Uyghur | Tibetan | Other ethnicities |

*(Table 1 continues on next page)*
The individual and pooled ORs of the association between ethnic affiliation and maternal or child health outcomes and service coverage are shown in the appendix (pp 9-13, 14-25) and figures 2 and 3. The pooled crude odds of maternal mortality were twice as high for ethnic minorities than for Han women (OR 2·16 [95% CI 0·97–4·82]). Similarly, the pooled crude ORs for neonatal mortality (1·45 [0·92–2·30]), infant mortality (1·68 [0·81–3·48]), and child mortality (2·02 [1·23–3·32]) were higher among ethnic minorities than among Han children (OR 0·34 [95% CI 0·24–0·47]), with high heterogeneity across studies (I² = 98–69%, p<0·0001; figure 2; appendix pp 15–16). The pooled adjusted ORs for antenatal care and facility birth were 0·54 (95% CI 0·42–0·71) and 0·76 (0·47–1·24), respectively (figure 3; appendix pp 19–20).

Ethnic minority women had lower odds of using antenatal care (OR 0·60 [95% CI 0·48–0·75]) or giving birth in health facilities (0·50–0·64) compared with Han women, but there was strong evidence for between-study heterogeneity (P = 0·97–95% and 95–8%, respectively; p=0·0001; figure 2; appendix pp 15–16). The pooled adjusted ORs for antenatal care and facility birth were 0·54 (95% CI 0·42–0·71) and 0·76 (0·47–1·24), respectively (figure 3; appendix pp 19–20).

The odds of any immunisation were much lower among ethnic minority children than among Han children (OR 0·34 [95% CI 0·24–0·47]), with high heterogeneity across studies (I² = 98–69%, p=0·0001; figure 2; appendix pp 17–18). After adjustment for confounders, the pooled OR for any immunisation was 0·57 (95% CI 0·44–0·74; figure 3; appendix pp 21–22).

Women of Hui ethnicity had lower odds of antenatal care (OR 0·48 [95% CI 0·33–0·72]) and facility birth (0·34 [0·16–0·72]) compared with Han women, but there was no difference in immunisation coverage (appendix p 23). Women and children of Tibetan and Uyghur ethnicities had lower odds of MCH care coverage (OR 0·27 [95% CI 0·09–0·83] and 0·39 [0·16–0·95], respectively) than the Han population (appendix pp 24–25).

The P statistics varied over a range from 0% to 99%, with most subgroups in the 80–90% range (appendix pp 14–25). The funnel plots were symmetric for each MCH indicator, with the Begg’s test (p=0·1143 for mortality, p=0·0913 for antenatal care, p=0·8926 for facility birth, p=0·3481 for hepatitis B immunisation, and p=0·2561 for other immunisations, separately) suggesting no evidence of publication bias for meta-analyses (appendix pp 26–30). The sensitivity analyses and meta-regression showed the summary measures of effects between ethnicity and each MCH indicator were stable (appendix pp 31–35).

The 15 ecological studies matching our inclusion criteria are described in table 3.50–59 Ten studies reported on maternal health outcomes and eight on child health outcomes (three reported on both). The number of population groups that were compared in the studies varied substantially; from two villages in Yunnan Province to a comparison between all 2296 counties in China.60,61 The ethnic composition of the geographically defined groups varied substantially, but only two studies explicitly defined a threshold above which groups could be defined as ethnic minority or examined associations between the proportional share of ethnic minorities and MCH indicators.62,63 Nearly all studies reported lower uptake of MCH care and higher mortality among ethnic minority than among non-ethnic minority populations. Interestingly, the two studies comparing large numbers of population groups found some ethnic minority populations that fared better than the Han majority. For example, Liu and colleagues64 found that uptake of

| Study design (period) | Study setting | Study population | Sample size | Indicators | Ethnic minority: number |
|----------------------|--------------|------------------|-------------|------------|-------------------------|
| Jiang Z et al, 2014 (C)43 | Cross-sectional survey (2012) | Nine rural counties in Guangxi, Shaanxi, Guizhou, and Gansu Province | Children younger than 5 years | BCG, OPV, DPT, hepatitis B, MV: scheduled (timely full) coverage | Not stated .. .. .. Other (no name): not stated |
| Qi et al, 2015(C)44 | Cross-sectional survey (2013) | Linxia Hui Autonomous Prefecture in Gansu Province | Children aged 2–3 years old | BCG, hepatitis B, OPV, DPT, MV: adequate coverage; childhood immunisation coverage | 2016 .. .. .. Other (Hui, Dongxiang, or others): 2688 |
| Zhou et al, 2016 (E)60 | Cross-sectional survey (2010) | 20 counties in Guangxi, Guizhou, Tibet, and Shaanxi Province | Children aged 12 months | EPI timely full coverage | 1057 .. .. .. 800 Zhuang: 492; Buyei: 210; Miao: 448; Other (Hui, Mongolian, Tuja, or others): 290 |
| Maternal health                                                                 | Completeness of data | Definitions of outcomes                                                                 | Definitions of ethnic groups | Statistical analysis                                                                 | Adjustment for confounders                                                                 |
|--------------------------------------------------------------------------------|----------------------|----------------------------------------------------------------------------------------|-----------------------------|---------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
| Lu et al, 2000 (C)^3^                                                        | Simple random sampling, but methods not stated | Not given | Antenatal care initiation at ≤12 gestational weeks; antenatal visits (≥5), birth in county or higher level hospital | Reported by respondent | Crude %, linear regression but treating the ethnicity as a continuous variable         | Paper reports regression analysis adjusted by confounders but data cannot be used because the ethnicity was treated as a continuous variable |
| An et al, 2002 (C)^4^                                                        | Multistage random sampling, data source clearly stated | High risk | Unclear risk | Low risk | Low risk | Low risk | Low risk | High risk | Paper reports regression analysis adjusted by confounders but data cannot be used because the ethnicity was treated as a continuous variable |
| Yan et al, 2003 (C)^5^                                                      | Stratified cluster random sampling, methods not clearly stated | Low risk | Unclear risk | Low risk | Low risk | High risk | Low risk | None |
| An et al, 2004 (C)^6^                                                      | Multistage random sampling, data source clearly stated | Low risk | Unclear risk | Antenatal visits (≥3) | Reported by respondent | Crude %, logistic regression and treating the ethnicity as a binary variable (Han and other ethnicities) | High risk Adjusted by education of women, source of income, financial situation of the family, parity, family health habits, education of village doctor, medical licence of village doctor, the maternal care awareness of village doctor, frequency of disinfection in village clinic, the distance between village and township |
| Li, 2004 (E)^7^                                                            | Multistage random sampling, data source clearly stated | Low risk | Unclear risk | Low risk | Low risk | Low risk | Low risk | Low risk | Adjusted by women's status, literacy, village type, distance to clinic |
| Fang et al, 2005 (C)^8^                                                     | Survey but methods not described | High risk | Unclear risk | Low risk | Low risk | Low risk | Low risk | Low risk | Adjusted by age, education, income, district |
| Li et al, 2008 (C)^9^                                                      | Multistage stratified cluster random sampling, methods clearly stated, data source clearly stated | Low risk | Unclear risk | Low risk | Low risk | Low risk | Low risk | None |
| Chang et al, 2009 (C)^10                                                    | Multistage random sampling, data source not clear | Low risk | Unclear risk | Low risk | Low risk | Low risk | Low risk | None |
| Cui et al, 2009 (C)^11                                                      | Multistage random sampling, data source not clear | Low risk | Unclear risk | Low risk | Low risk | Low risk | Low risk | None |
| Zhu et al, 2009 (C)^12                                                      | Random sampling, methods not clearly stated, data source not clearly stated | Low risk | Unclear risk | Antenatal visits (≥1), facility birth not defined | Reported by respondent | Crude %, binary logistic regression | High risk Adjusted by education, whether attended reproductive health training, occupation, Hukou or not |
| Lei et al, 2010 (C)^13                                                      | Multistage random sampling, methods clearly stated, data source clearly stated | Low risk | Unclear risk | Antenatal visits (≥5) | Reported by respondent | No crude %, logistic regression | Low risk Adjusted by Qinba Project County or not, women's age, education, health awareness, parity, time to township health centre, time to county hospital, annual income, year of birth |
| Risk Low risk | Unclear risk | Low risk | Low risk | Low risk | Low risk | Low risk | Low risk | (Table 2 continues on next page) |
| Risk | Characteristics of study design | Completeness of data | Definitions of outcomes | Definitions of ethnic groups | Statistical analysis | Adjustment for confounders |
|------|---------------------------------|----------------------|-------------------------|-----------------------------|---------------------|--------------------------|
| Low  | Long et al., 2010 (E)           | Replacement sample if no one home | 1st trimester defined as ≤12 weeks gestation, birth in township or higher level hospital | Reported by respondent | No crude %, logistic regression with the data in 2007 | Adjusted by age, education, history of fetal loss, distance to health facility, parity, income, insurance participation |
| Low  | Feng, 2011 (C)                  | Not given            | Maternal mortality not defined | Reported by respondent | Crude %, no statistical analysis | None |
| High | Liu et al., 2011 (E)            | Not given            | Antenatal visits (≥5), birth in township or higher level hospital | Reported by respondent | No crude %, logistic regression | Adjusted by age, family number, mother and father education, household size, parity, wealth index, altitude of county, province |
| Low  | Ren, 2011 (E)                   | No-one refused to take part | First trimester defined as ≤16 weeks gestation | Reported by respondent | No crude %, logistic regression, adjustment for survey not clear | Low risk |
| Low  | Rong et al., 2011 (C)           | Not given            | Facility birth not defined | Reported by respondent | Crude%, χ² test | None |
| High | Chen et al., 2013 (C)           | Not given            | First antenatal visit within the first 3 months of last menstrual period | Reported by respondent | Crude %, logistic regression but not reporting the diversities among ethnicities | None |
| Low  | Jiang et al., 2014 (C)          | 100%                 | Caesarean section        | Reported by respondent | Crude %, logistic regression and treating the ethnicity as a binary variable (Han and other ethnicities) | High risk |
| Low  | Du et al., 2015 (E)             | Not given            | Maternal deaths not defined, birth in township or higher level hospital | Low risk | County-based: non-minority if ethnic minorities <37·8% of population, minority county if ethnic minorities >37·8% of population | Low risk |
| High | Long, 1996 (C)                  | 100%                 | Child mortality not defined | Reported by respondent | Crude %, χ² test, adjustment for survey design not clear | None |
| Low  | Li, 2004 (E)                    | 5% missing data      | Childhood immunisation coverage not defined (from mother’s report) | Reported nationalty of household head | No crude %, logistic regression, appropriate weighting | Adjusted by women’s status, literacy, village type, distance to clinic |
| High | Wei et al., 2005 (C)            | Not given            | Hepatitis B coverage not defined (from blood test) | Reported by respondent | Crude %, χ² test, adjustment for survey design not clear | None |
| Low  | Risk                            | Unclear risk         | High risk                | Low risk | High risk | High risk |

**Child health**

| Risk | Characteristics of study design | Completeness of data | Definitions of outcomes | Definitions of ethnic groups | Statistical analysis | Adjustment for confounders |
|------|---------------------------------|----------------------|-------------------------|-----------------------------|---------------------|--------------------------|
| Low  | Long, 1996 (C)                  | 100%                 | Child mortality not defined | Reported by respondent | Crude %, χ² test, adjustment for survey design not clear | None |
| Low  | Li, 2004 (E)                    | 5% missing data      | Childhood immunisation coverage not defined (from mother’s report) | Reported nationalty of household head | No crude %, logistic regression, appropriate weighting | Adjusted by women’s status, literacy, village type, distance to clinic |
| High | Wei et al., 2005 (C)            | Not given            | Hepatitis B coverage not defined (from blood test) | Reported by respondent | Crude %, χ² test, adjustment for survey design not clear | None |
| Low  | Risk                            | Unclear risk         | High risk                | Low risk | High risk | High risk |

(Table 2 continues on next page)
Table 2: Quality criteria for individual studies of ethnicity and MCH indicators

| Characteristics of study design | Completeness of data | Definitions of outcomes | Definitions of ethnic groups | Statistical analysis | Adjustment for confounders |
|--------------------------------|----------------------|-------------------------|-----------------------------|---------------------|---------------------------|
| Probability proportionate to size (PPS) sampling, data source clearly stated | Not given | 3 doses of hepatitis B vaccine within 12 months, first dose of hepatitis B vaccine within 24 h of delivery (from mother's report) | Reported by respondent | Crude %, χ² test | None |
| Risk | Low risk | Low risk | Low risk | Low risk | Low risk |
| Yang, 2008 (C) | Routine data, data source clearly stated | Not given | Child mortality not defined | Reported by respondent | Crude %, no statistical analysis | None |
| Risk | Low risk | Unclear risk | Low risk | Low risk | High risk |
| Gao et al, 2009 (C) | Routine reporting system not described | Not given | Child mortality not defined | Reported by respondent | Crude %, χ² test | None |
| Risk | Low risk | Unclear risk | Low risk | Low risk | None |
| Liang et al, 2009 (E) | Multistage random sampling, data source clearly stated | 94% response rate | 3 doses of hepatitis B vaccine within 12 months, first dose of hepatitis B within 1 day after birth (from mother’s report, household immunisation certificate, facility immunisation card, and blood test) | Reported by respondent | Weighted %, logistic regression with the data of children born before 2001 | Adjusted by age, sex, urban or rural, region, place of birth |
| Risk | Low risk | Low risk | Low risk | Low risk | Low risk |
| Zhou et al, 2009 (E) | Two stage, stratified cluster sampling, data source clearly stated | Not given | First dose of hepatitis B within 1 day after birth, hepatitis B coverage not defined (from mother’s report, household immunisation certificate and facility immunisation card) | Reported by respondent | Crude %, logistic regression only for timely birth dose coverage, adjustment for survey design not clear | Low risk |
| Risk | Low risk | Low risk | Low risk | Low risk | Low risk |
| Wang et al, 2012 (C) | Simple random sampling, methods not clearly stated | Not given | Childhood immunisation coverage not defined, inconsistency between the text and the title (from mother’s report) | Reported by respondent | Crude %, logistic regression | Low risk |
| Risk | Low risk | Unclear risk | High risk | Low risk | None |
| Ding et al, 2014 (C) | Multistage random sampling, data source clearly stated | Not given | Childhood immunisation coverage not defined (from mother’s report) | Reported by respondent | Crude %, χ² test | None |
| Risk | Low risk | Unclear risk | High risk | Low risk | None |
| Jiang Z et al, 2014 (C) | Multistage stratified cluster random sampling, data source not clear | 80% | Scheduled immunisation coverage based on “international child basic EPI framework” (from mother’s report and household immunisation certificate) | Reported by respondent | No crude %, logistic regression, adjustment for survey not clear | Adjusted by mother’s age, whether in poverty or not, education of mother, mother married or not |
| Risk | Low risk | Unclear risk | High risk | Low risk | High risk |
| Qi et al, 2015 (C) | Lot Quality Assurance Sampling, methods clearly stated, data source clearly stated | Not given | Adequate immunisation coverage defined as having received the full number of doses on time; childhood immunisation coverage defined as having received the full number of doses of eight vaccines on time (from immunisation scars, household immunisation certificate and facility immunisation card) | Reported by respondent | Crude %, χ² test, logistic regression with an integrated indicator of eight vaccines | Adjusted by age, living place, mother’s education, place to receive vaccines, time spent on the road to receive vaccines |
| Risk | Unclear risk | Low risk | Low risk | Low risk | Low risk |
| Zhou et al, 2016 (E) | Two-stage cluster sampling, data source clearly stated | Not given | EPI timely full coverage defined as having received full doses of DTP, OPV, MV, and BCG by age 12 months (from household immunisation certificate and facility immunisation card) | Reported by respondent | No crude %, logistic regression, no adjustment for survey design | None |
| Risk | Low risk | Unclear risk | Low risk | Low risk | None |

MCH=maternal and child health. C=Chinese paper. E=English paper. EPI=Expanded Programme on Immunisation by WHO. Hepatitis B=hepatitis B vaccine. DPT=diphtheria, pertussis, and tetanus vaccine. OPV=oral polio vaccine. BCG=Bacillus Calmette-Guérin vaccine. MV=measles vaccine.

Table 2: Quality criteria for individual studies of ethnicity and MCH indicators
facility-based delivery, antenatal care, and postnatal care was higher among Hui and Naxi women than among the Han, while Wang and colleagues reported lower under-5 mortality rates among Koreans and Manchus compared with the Han.

Discussion

Our systematic review provides strong evidence of poorer health outcomes and MCH care access among ethnic minorities than among Han populations in western China. Results were remarkably consistent across MCH indicators. The pooled odds of child mortality were twice as high for ethnic minorities as for Han. Ethnic minority women were less likely than Han women to use antenatal care, to give birth in a health facility, or to immunise their child. After taking account of the potential confounding effects of wealth or education, ethnic minority women were less likely to use antenatal care or to immunise their children compared with Han women.

Compared with previous studies, it is a strength that we draw from both English and Chinese sources, and that we include group as well as individual comparisons. Anderson and colleagues have argued that one should draw data from government health statistical agencies, but government data in China rely on geographic proxy measures (eg, autonomous provinces, prefectures, or counties) rather than on information from distinct ethnic groups. Geographic proxy measures have policy value in that benefits can be targeted at administratively defined groups with clear channels of responsibility.

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Figure 2: Pooled crude ORs between ethnicity and maternal and child health indicators

| Datasets | Ethnic minorities | Han | OR (95% CI) | P |
|----------|------------------|-----|-------------|---|
| Maternal mortality 3 1227 1405716 1037 1479334 | 2.16 (0.97-4.82) 86.0% |
| Neonatal mortality 5 115 8687 85 11445 | 1.45 (0.92-2.30) 26.8% |
| Infant mortality 5 244 8687 115 11445 | 1.68 (0.81-3.48) 75.8% |
| Child mortality 9 343 10075 184 13505 | 2.02 (1.23-3.32) 71.0% |

Figure 3: Pooled adjusted ORs between ethnicity and maternal and child health indicators

| Datasets | Ethnic minorities | Han | OR (95% CI) | P |
|----------|------------------|-----|-------------|---|
| Antenatal care 12 1227 11207 16498 | 0.54 (0.42-0.71) 87.2% |
| Birth in health facilities 2 5485 9427 | 0.76 (0.47-1.24) 72.9% |
| Hepatitis B immunisation 35 555 11138 191696 419394 | 0.43 (0.22-0.87) 96.9% |
| BCG immunisation 1 1 947 | 1.68 (0.55-5.14) 1.00 |
| DPT immunisation 1 1 947 | 0.55 (0.44-0.70) 1.00 |
| MV immunisation 1 1 947 | 1.29 (1.00-1.65) 1.00 |
| OPV immunisation 1 1 947 | 0.90 (0.70-1.15) 1.00 |
| Any immunisation 28 4642 18289 193661 426861 | 0.57 (0.44-0.74) 92.3% |
### Articles

| Comparison groups and setting (period) | Data sources | Indicators (definition) | Definition of ethnic groups | Statistical analysis | Results |
|----------------------------------------|--------------|-------------------------|-----------------------------|----------------------|---------|
| **Maternal health**                    |              |                         |                             |                      |         |
| He et al, 2000 (C)                      | One ethnic minority county (Huangcaoba) in Gejiu city of Yunnan Province (1999) versus 20 poor/rich counties and rural/urban counties in 16 Provinces (1996) | Cross-sectional survey in one village (1999), methods not stated; national data from a cross-sectional survey in 16 Provinces (1993-96) | One county in autonomous prefecture (55% Yi, 33% Miao, 3% Dai, 9% Han); ethnic composition of the comparison groups not stated | None | (1) ≥1 antenatal visit; Huangcaoba: 18.20%; national (1996): poor counties 28.50%, rural average 68.30%, rich counties 75.10%, urban average 95.60%; (2) facility birth: Huangcaoba: 10.10%; national (1996): poor counties 6.50%, rural average 21.70%, rich counties 38.20%, urban average 87.30% |
| Risk Low risk                           | Luo et al, 2002 (C) | Two counties in Yunnan Province with different ethnic composition (1995-2000): Xundian and Jingdong | Cross-sectional survey (2001), methods clearly stated | Facility birth (not defined) | Xundian: Hui and Yi Autonomous County Jingdong: Yi Autonomous County | High risk | Non-minority versus minority prefectures (1996: 73.2% vs 51.3%, rate ratio 0.7; 2000: 89.1% vs 75.1%, rate ratio 0.8) |
| Risk Low risk                           | Li et al, 2008 (E) | 11 autonomous minority prefectures versus five non-minority counties in Yunnan Province | 2000 census and National Maternal and Child Health Surveillance System | % women who had antenatal examination | Unadjusted rate ratios | (1) Pearson correlation between maternal mortality ratio and % minority groups; (2) Stepwise linear regression of maternal mortality ratio and % minority groups, adjusting for average number of village doctors and % of villages without doctors | (1) Correlation coefficient 0.124; (2) Regression coefficient 8.3 (95% CI 1.7-13.9); p=0.006 |
| Risk High risk                          | Du et al, 2009 (E) | 24 counties in Xinjiang Province with different ethnic composition (1997) | Confidential enquiry and verbal autopsy of maternal deaths, using multiple data sources | Maternal mortality (ICD-9) | % of minority populations in each county | High risk |         |
| Risk Low risk                           | Wu et al, 2010 (C) | 31 ethnic minority counties in Sichuan Province versus Sichuan Province (2001-09) | Maternal and child health information system, methods not stated | Facility birth (not defined); maternal mortality (not defined) | Low risk | (1) Facility birth: Province 67.3% (2001-09) vs 51.8% (2000); ethnic counties 35.1% (2001) vs 51.8% (2009) (2) Maternal mortality: Province 41.7 deaths per 100,000 livebirths (2009); ethnic counties 98.6 deaths per 100,000 livebirths (2009) |         |
| Risk Low risk                           | Rong et al, 2011 (C) | Comparison between six counties with different ethnic composition: Lushi county in Yunnan; Congjiang county in Guizhou; Congjiang county in Tibet (period not clear) | Cross-sectional survey, method clearly stated (year not stated) | Facility birth (not defined) | “Main” ethnic minorities in each county: Leshan: Miao Congjiang: Dong Nongchuan: Jingpo Luxu: Dai Hualong: Hui and Tibetan; Congjiang: Congjiang: Congjiang: Congjiang: Congjiang: Tibet | High risk | Leshan, 49.3%; Congjiang, 41.9%; Longhuang, 48.6%; Luxu, 71.4%; Hualong, 66.7%; Congjiang, 45.8% |
| Risk Low risk                           | Wellhonner et al, 2011 (E) | One ethnic minority community in catchment area of Surmang clinic, Yushu county, Qinghai Province (1999-2004) versus western China (2000-05) and Qinghai Province (2003) | Cross-sectional survey in one community (clearly described) and national data from MCH reporting system and health services survey | Facility-based delivery (not defined) | “All were Tibetan, from the Kham region”; ethnic composition of Qinghai or western China not stated | High risk | Ethnic minority community, 0.2%; western China, 66.6%; Qinghai Province, 34.4% |
| Risk Low risk                           |                      |                         |                             |                      |         | (Table 3 continues on next page) |

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**Notes:**
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(Continued from previous page)

| Risk | Comparison groups and setting (period) | Data sources | Indicators (definition) | Definition of ethnic groups | Statistical analysis | Results |
|------|----------------------------------------|--------------|------------------------|----------------------------|---------------------|---------|
| Low risk | Two counties (Yushu, Rangqian) in Yushu Tibetan region, Qinghai Province vs Qinghai Province (2008), Qinghai Rural Area (2008), Type IV Rural Area (the least developed area, 2006) and China (2008) | Cross-sectional survey in the two counties (2009) and multiple data sources for national and provincial comparison, methods not stated | ≥1 antenatal visit; facility birth (at any level) | Two counties in autonomous prefectures; “The survey only used Tibetan language” | None | Low risk (1) ≥1 antenatal visit: China 94.4%, Qinghai 80.4%, ethnic minority counties 49.1%; (2) facility birth: China 88.6%, Qinghai 86.1% and 84.6% for Qinghai rural areas, Type IV rural areas (2006) 32%, ethnic minority counties 9 5% |
| Low risk | 993 villages with different ethnic composition in 14 counties in Sichuan, Guansu and Yunnan Province where MCH care is accessible (2011) | Unclear risk | Cross-sectional survey of women’s representatives and village leaders in each village | Unclear risk | Low risk | Low risk (1) Hospital-based delivery: Han 86%, non-Han 70%, Yi 58%, Tibetan 54%, Miao 82%, Hui 95%; Naxi 94%; other 90% (p<0.05 for Yi, Tibetan, Hui, and Naxi); (2) any prenatal care: Han 94%; non-Han 80%; Yi 68%; Tibetan 80%; Miao 83%; Hui 96%; Naxi 97%; other 98% (p<0.05 for Yi and other); (3) ≥5 prenatal care: Han 69%; non-Han 55%; Yi 40%; Tibetan 33%; Miao 59%; Hui 88%; Naxi 93%; other 51% (p<0.05 for Yi, Tibetan, Hui, and other) |
| Low risk | Two ethnic minority counties with low hospital delivery rates in two ethnic minority autonomous prefectures in Sichuan Province (Butuo and Daofu county; 2011) | Unclear risk | Hospital-based delivery (not clearly defined) | Low risk | Low risk | Butuo county, 22%; Daofu county, 47% |
| Low risk | Seven regions with different ethnic composition in Tibet Autonomous Region (1990) | Infant mortality rate, not defined | % Tibetan nationality in each region | None | Low risk | Infant mortality ranges from 82 per 1000 in Lhasa to 197 per 1000 in Nariu region |
| Low risk | Two counties in Yunnan Province with different ethnic composition (1995–2000): Xundian and Jingdong | Timely first dose of hepatitis B vaccine within 48 h after delivery; hepatitis B vaccine coverage in neonates (not defined); 3-dose immunisation rate of hepatitis B vaccine | Xundian: Hui and Yi Autonomous County, Jingdong: Yi Autonomous County | None | High risk | Infant mortality ranges from 82 per 1000 in Lhasa to 197 per 1000 in Nariu region |
| Low risk | 11 autonomous minority vs five non-minority prefectures in Yunnan Province | Infant mortality (per 1000 livebirths), child mortality (per 1000 children aged 1-4 years) | % minorities is 14.5% in non-minority prefectures and 58.4% in minority prefectures | High risk | Unadjusted rate ratios | (1) Infant mortality in non-minority vs minority prefectures (1996: 42.4 per 1000 vs 54.0 per 1000, rate ratio 1.3; 2000: 32.6 per 1000 vs 38.6 per 1000, rate ratio 1.2); (2) child mortality in non-minority vs minority prefectures (1996: 53.9 per 1000 vs 67.7 per 1000, rate ratio 1.3; 2000: 40.7 per 1000 vs 46.5 per 1000, rate ratio 1.1) |

(Continued on next page)

**Articles**

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Table 3: Summary and quality of ecological studies of ethnicity and MCH indicators

| Risk | Comparison groups and setting (period) | Data sources | Indicators (definition) | Definition of ethnic groups | Statistical analysis | Results |
|------|--------------------------------------|--------------|-------------------------|-----------------------------|----------------------|---------|
| High risk | 96 counties or townships in Xinjiang Uighur Autonomous Region | 2000 census, 2005 Statistical Yearbooks and 2005 Yearly Macroeconomic Statistics, methods not stated | Infant mortality rate (not defined) | Comparison between Uighur and Han, but not clear how ethnicity of county/township is ascertained | Linear mixed effect model, adjusting for urban/rural, tertiary education and unemployment | Counts or townships with Uighur nationality have higher infant mortality rates (p=0.0000) |
| Low risk | 31 ethnic minority counties in Sichuan Province, Sichuan (2009) | Maternal and child health information system, methods not stated | Infant mortality rate (not defined) | “31 ethnic minority counties, all of whose hospital delivery rate was less than 50% in 2008”, definition not clear | Low risk | None |
| High risk | Counties with different ethnic composition in western China: Leshan and Congjiang counties in Guizhou, Longchuan and Luxi counties in Yunnan, Hualong county in Qinghai, Congjiang county in Tibet versus Province | “Ethnic minority region MCH health information strengthening programme”, routine provincial data. Methods not stated | Under-5 mortality (not defined) | Autonomous counties: Congjiang (Dong 48.6%, Miao 43.9%, Zhuang 4.7%, Yao 1.9%, Han 0.9%), Leshan (Miao 90.8%, Han 7.7%, Sui 1.5%), Longchuan (Jingpo 35.3%, Han 35.3%, Dai 20.6%, Hui 2.9%, Deang 2.9%, Chang 2.9%); Luxi (Han 42.9%, Dai 35.7%, Jingpo 14.2%, Deang 7.1%); Hualong (Hui 47.3%, Tibetan 23.9%, Han 16.9%, Salar 11.3%); Gongbujiangda (Tibetan 100.0%); | High risk | None |
| Low risk | 2296 counties with different ethnic composition in China (287 minority and 2009 non-minority; 1996 and 2012) | Multiple data sources between 1990 and 2013, with rigorous consistency checks and adjustments for completeness | Under-5 mortality (deaths in children under 5 years per 1000 livebirths) | At least 50% of county population belongs to one specific ethnic group | High risk | Population weighted average in each county in 1996 and 2012 |
| Low risk | Comparison between Provinces with different ethnic composition using cross-sectional survey (2010) | Cross-sectional household surveys with two-stage cluster sampling before (2004) and after (2010) an intervention in each county (clearly described): Household immunisation certificates, facility immunisation card and immunisation scars were checked | Timely full immunisation (“as defined by WHO”) | “The majority of children in Guanxi, Guizhou and Tibet belonged to one of China’s ethnic minorities, virtually all in Shaanxi Province were Han ethnicity” | Low risk | No crude %, logistic regression, no adjustment for survey design but adjustment for place of birth, region and mobility, parents’ migration status, and EPI-related knowledge |

MCH = maternal and child health. C = Chinese paper. E = English paper. EPI = Expanded Programme on Immunisation by WHO. Hepatitis B = hepatitis B vaccine. DPT = diphtheria, pertussis, and tetanus vaccine. OPV = oral polio vaccine. BCG = Bacillus Calmette–Guérin vaccine. MV = measles vaccine.

However, the share of ethnic minorities in Autonomus Regions such as Xinjiang (59.5%), Guangxi (37.2%), Ningxia (35.2%), and Inner Mongolia (20.5%) are not dissimilar to those in Qinghai (47.0%), Guizhou (35.7%), and Yunnan (33.4%), Provinces not designated as Autonomus Regions. If one wants to make inferences about the health status or access to care for specific ethnic groups, and understand the underlying causes of...
variation, then proxy measures are a poor substitute for individual comparisons.

Little analytical work has been done on the underlying reasons for health gaps between Han and ethnic minority populations in China. Much of the international literature on the causes of health differentials between ethnic minority and non-ethnic minority populations draws from indigenous populations in high-income countries, including Aboriginal Canadians or Australians, and it is uncertain whether these explanatory models apply to China. In China, ethnic minority status is associated with economic and educational disadvantages, rural residence, mountainous topography, and poor infrastructure, but living conditions vary substantially across and even within specific ethnic groups, and a unique analytical framework encompassing all ethnic minorities would not be appropriate. For example, two of the largest ethnic groups, the Manchus and the Hui, are among the most urbanised and their income levels are not dissimilar to that of the Han majority. However, the Hui are highly dispersed across the country, and there are distinct, heterogeneous subgroups with their own geographical ties and cultural practices. The Yi ethnic group, on the other hand, are mostly subsistence farmers living in remote mountainous areas of southern Sichuan, with low levels of education and little access to formal health care. The substantial heterogeneity in child mortality between ethnic minorities shown by Wang and colleagues shows the diversity among ethnic minority groups. In 2012 six minority groups (Yi, Tibetan, Kyrgyz, Monba, and Tajik) lived in counties with child mortality rates greater than 40 per 1000 livebirths, while three groups lived in counties with child mortality rates very similar to the Han (12-1, 14-1, and 14-6 per 1000 among Manchu, Zhuang, and Yao, respectively, vs 12-8 per 1000 among Han). Wider environmental factors such as mountainous terrain and poor infrastructure might be as important as individual or household characteristics in explaining the poverty gap between Han and minority populations, so the same might be true for health gaps. Yet, the studies in our review that had taken account of confounders such as income and education still reported poor access to MCH care, pointing to ethnic differentials that persist beyond the economic and educational disadvantages of certain ethnic groups.

Although this study identified more papers than earlier reviews on this topic, few aimed to explain the health disparities between the Han majority and ethnic minorities. Indeed, ethnic affiliation was a secondary determinant—a factor to adjust for in the analysis—rather than a focus of the study per se. Many studies aggregated non-Han ethnic groups into a single or “other” ethnic minority category, thereby masking possible variation between individual ethnic groups. Qualitative research has explored some of the reasons why ethnic minority populations might have low access to care, but the number of studies is small. Research among Yi and Tibetan women, for example, has suggested that women might choose to give birth at home because of the high cost of care, the poor quality of township hospitals, and the cultural inappropriateness of birthing practices that cause women discomfort and embarrassment. Low levels of education and health-care knowledge could also contribute to low uptake of MCH care among ethnic minorities like Yi, Miao, Tibetan, Dong, Uygur, and Yugur. Local beliefs, behaviours, and fears that translate into women’s suspicion of delivering in clinics or hospitals might play a part, but there is no uniformity of beliefs and behaviours across population groups and findings from small ethnographic studies are difficult to generalise. Although there is evidence from western China that geographic accessibility in ethnic minority areas is poorer, there is dispute over how important a barrier to care it is. Some argue that it is critical, while others suggest that its significance has been overstated.

Our search was comprehensive and systematic, but our design might have some limitations. First, we focused our analysis on ethnic minorities in western China because poverty is concentrated in this region and three-quarters of all ethnic minorities live there. Ethnic minorities such as the Manchus tend to live in the more industrialised north and northeast, and their degree of urbanisation and lifestyle approximates that of the Han. Because we compare ethnic minority and Han populations in a region which is less developed and has worse health outcomes than eastern or central China, our estimates of effect underestimate the difference between ethnic minority and Han populations at a national level.

Second, we only included studies comparing individual ethnic groups for which odds ratios with 95% CIs were available. This means that studies relying on census data but not providing sample sizes were excluded. We are aware of five such studies, all of which confirmed the higher infant and child mortality of ethnic minority populations compared with Han populations. Third, we excluded studies making ecological comparisons at the province or regional level, even though some provinces are designated Autonomous Regions. As outlined above, autonomous provinces or regions are too diverse in ethnic composition to make meaningful comparisons. Fourth, we used odds ratios for our estimates of effect because almost all studies used logistic regression. With outcomes as common as the MCH indicators reported here, odds ratios are a poor approximation for risk ratios, and care has to be taken in the interpretation of the magnitude of effect. Fifth, there was great heterogeneity between the studies, though the pooled odds ratios for the various indicators were remarkably consistent. The sensitivity analyses and meta-regression showed that publication year and sample size were not significantly associated with the
pooled odds ratio, and that no single study affected the aggregated associations between ethnicity and MCH indicators. Sixth, most data were collected between 2000 and 2009, and we were unable to examine changes over time in the strength of association between ethnicity and MCH outcomes between 1990 and 2016. Four studies reported data points over two or more periods, but only one found a change over time in ethnic disparities for hepatitis B immunisation coverage. Lastly, misreporting of ethnicity is not a problem in China because a person’s ethnicity is determined at birth, depending on the parents’ ethnic group. When both parents belong to the same ethnic group the child will have its parents’ ethnicity; when the parent’s ethnicity differs the parents can choose between the mother’s or the father’s ethnicity.

There is a lack of peer-reviewed research that seeks to explain ethnic minority health differentials in China. Yet China, unlike other countries, has a wealth of primary data that could further our understanding of why ethnic minority populations are lagging behind. Many large-scale surveys, including the China National Health Service Surveys, China Health and Nutrition Surveys (CHNS), and China Family Panel Survey (CFPS), collect data for MCH indicators, ethnicity, and other sociodemographic characteristics of individuals and households. Analyses could go beyond the mere descriptions of inequalities by region or by urban and rural areas, and aim to explore how sociodemographic characteristics, including ethnicity, interact to cause variation in access to care. Similarly, the 10-yearly censuses collect data for individual ethnicity, health outcomes, and sociodemographic factors, allowing a detailed exploration of variations between ethnic groups over time.

In China, the delivery of health services to remote areas where many ethnic minorities live is difficult because of severe shortage in health professionals, poor infrastructure, low population density, and complex migration patterns. Over the past 20 years, the Chinese Government has introduced several strategies that aim specifically at reaching ethnic minorities as well as strategies that aim to reach remote and poor populations in general. The latter includes medical insurance to rural residents through the New Cooperative Medical Scheme, the supply of free public health services to primary care facilities in rural areas and human resource policies to train, deploy, and retain health-care professionals in rural areas—including the training of ethnic minority health-care professionals. The Targeted Poverty Alleviation Project has been launched since 2016 to increase the accessibility to local health care among families officially registered as Poverty-stricken Households with a zero deposit or payment strategy. Furthermore, the government has encouraged the entry of traditional medicine practiced by various ethnic groups into the medical market and some provinces have recently opened new departments specifically to promote health development for ethnic minorities. Whether these policies will be successful in improving health outcomes among ethnic minorities remains to be seen. As MCH outcomes continue to improve nationally, ethnic minorities will take a greater share of the overall burden of adverse MCH outcomes, and further strategic investments to address the specific challenges faced by people living in remote areas will become necessary.

Contributors
YH was involved in extracting data, doing data synthesis, interpreting results, and writing the article. DS assisted with protocol design and development, extracted data, interpreted results, and drafted and revised the Article. LP and FT were involved in data extraction and Article writing. JP was involved in the concept, design, interpretation, and writing of the Article. CR designed the research protocol, assisted with data extraction and data synthesis, interpreted the results and wrote the Article. All authors approved the final submitted version.

Declaration of interests
We declare no competing interests.

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