

Review

The Social Determinants of Infant Mortality and Birth Outcomes in Western Developed Nations: A Cross-Country Systematic Review

Daniel Kim^{1,2,*} and Adrianna Saada³

¹ Behavioural and Policy Sciences Department, RAND Corporation, 20 Park Plaza, Suite 920, Boston, MA 02116, USA

² Department of Social and Behavioural Sciences, Ecole des Hautes Etudes en Santé Publique, Rennes 35043, France

³ Center for Health Decision Science, Harvard School of Public Health, Boston, MA 02115, USA; E-Mail: adrianna.saada@gmail.com

* Author to whom correspondence should be addressed; E-Mail: dkim@rand.org.

Received: 3 February 2013; in revised form: 26 April 2013 / Accepted: 16 May 2013 /

Published: 5 June 2013

Abstract: Infant mortality (IM) and birth outcomes, key population health indicators, have lifelong implications for individuals, and are unequally distributed globally. Even among western industrialized nations, striking cross-country and within-country patterns are evident. We sought to better understand these variations across and within the United States of America (USA) and Western Europe (WE), by conceptualizing a social determinants of IM/birth outcomes framework, and systematically reviewing the empirical literature on hypothesized social determinants (e.g., social policies, neighbourhood deprivation, individual socioeconomic status (SES)) and intermediary determinants (e.g., health behaviours). To date, the evidence suggests that income inequality and social policies (e.g., maternal leave policies) may help to explain cross-country variations in IM/birth outcomes. Within countries, the evidence also supports neighbourhood SES (USA, WE) and income inequality (USA) as social determinants. By contrast, within-country social cohesion/social capital has been underexplored. At the individual level, mixed associations have been found between individual SES, race/ethnicity, and selected intermediary factors (e.g., psychosocial factors) with IM/birth outcomes. Meanwhile, this review identifies several methodological gaps, including the underuse of prospective designs and the presence of residual confounding in a number of studies. Ultimately,

addressing such gaps including through novel approaches to strengthen causal inference and implementing both health and non-health policies may reduce inequities in IM/birth outcomes across the western developed world.

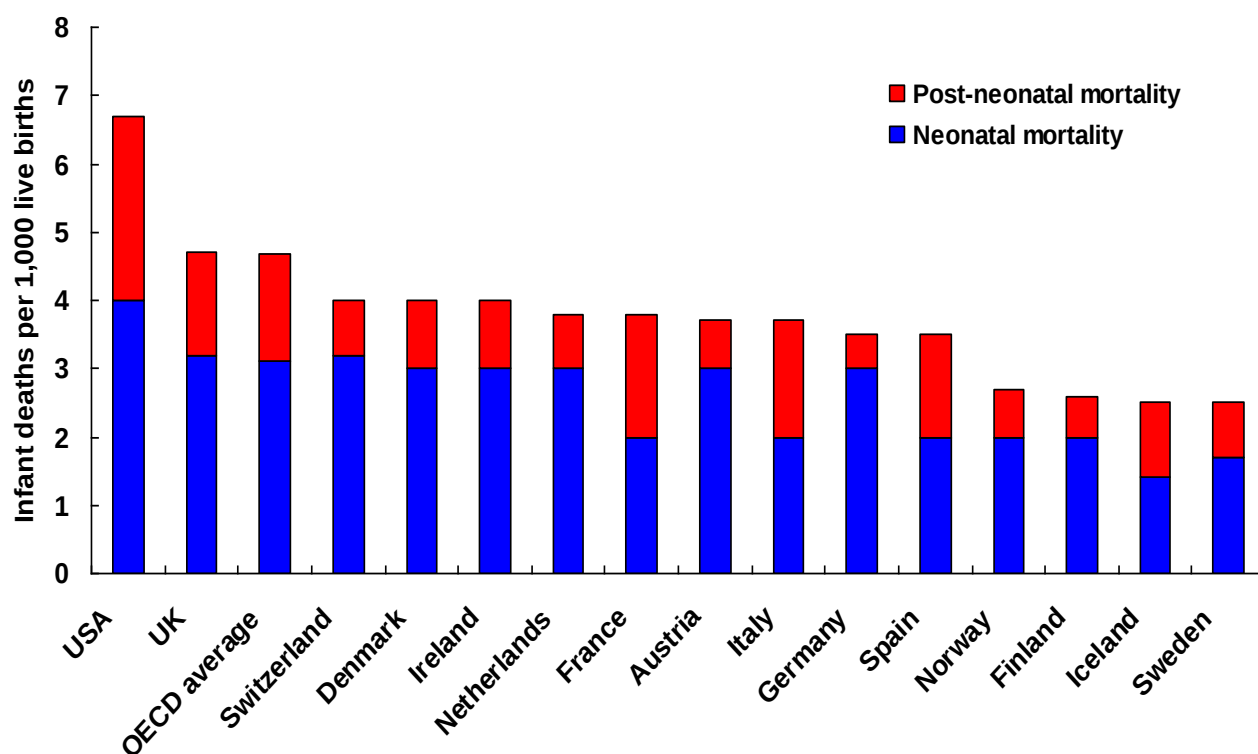
Keywords: social determinants of health; infant mortality; birth outcomes; preterm birth; United States; Western Europe

1. Introduction

1.1. Between-Country Variations in IM/Birth Outcomes

Infant mortality (IM), an important health outcome during the first year of life, is unequally distributed across countries at a global level [1]. Among Organization for Economic Co-operation and Development (OECD) countries, in 2008, infant deaths per 1,000 live births ranged from a low of 1.8 in Luxembourg to a high of 15.2 in Mexico [2]. Although advances in medicine and public health in the western industrialized world over the course of the 20th century produced major reductions in aggregate infant mortality rates (IMR), the United States (USA) ranks poorly compared to most other high income economies [2,3], with an IMR of 6.7 deaths per 1,000 live births in 2008 [2]. IMRs in the Western European (WE) nations of the United Kingdom (UK), France, Germany, and Nordic countries ranged from 2.5 to 4.7 deaths per 1,000 live births (Figure 1) [2].

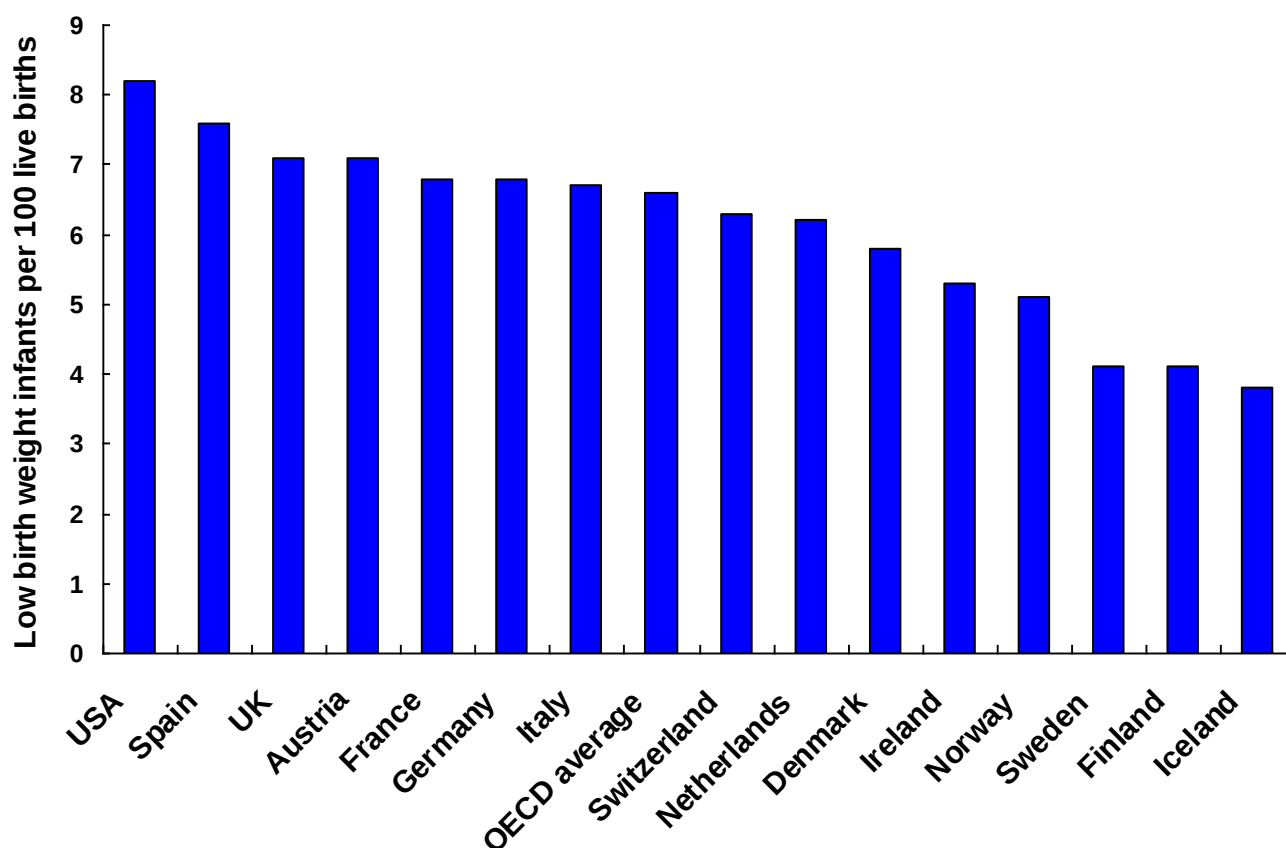
Figure 1. Infant mortality rates (number of infant deaths per 1,000 live births) in 2008 in selected OECD member countries. *Source:* OECD Health Data 2010 (April 2011 version) and WHO Global Health Observatory 2011.



Cross-national variations in birth outcomes are equally apparent in the fetal mortality rate (FMR), which includes spontaneous intrauterine deaths occurring at ≥ 20 weeks of gestation. Annual fetal deaths account for almost as much reproductive loss as IM in the USA, with a FMR of 6.2 fetal deaths per 1,000 live births and fetal deaths in 2005 [4]. Slightly lower FMRs were observed for WE countries in 2000 [5]. Neonatal mortality, or death occurring at ≤ 28 days of age, shows similar patterns. The 2006 USA neonatal mortality rate (NMR) was 4.5 deaths per 1,000 live births [6]. In 2000, the NMR was ≤ 3 deaths per 1,000 live births in each of France, Germany, and Nordic countries and 4 deaths per 1,000 live births in the UK [5].

Preterm birth (PTB) (< 37 weeks gestation) and very preterm birth (VPTB) (< 32 weeks gestation) are leading causes of mortality and morbidity in infants worldwide [7–9]. In 2005, 7.5% of all births in developed countries were preterm. PTB rates were lowest in Europe (6.2%) and highest in North America (10.6%) [7]. Meanwhile, 12.2% of all USA births were preterm in 2009—a significant decrease since 2006 [10]. PTB is closely linked to low birth weight (LBW) and very low birth weight (VLBW)—infants weighing less than 2,500 grams and 1,500 grams, respectively. Globally, LBW infants have a 20 times higher risk of death than heavier infants [9]. LBW infants account for 8.2% of all live births in the USA and 4.8% to 7.1% of all live births in WE countries (Figure 2) [11].

Figure 2. Infant low birth weight rates (number of low birth weight infants per 100 live births) in 2008 in selected OECD member countries.* *Source:* OECD Health Data 2011 (April 2011 version), World Bank 2011 (World Development Indicators), and WHO Regional Office for Europe (Health for All Database).



* Data corresponds to 2007 for the USA, Netherlands, Norway and Sweden; 2006 for Italy; and 2004 for France.

IM and birth outcomes are key population health indicators, for three primary reasons. First, IM is a widely accepted indicator of social development and economic change [12], and IM/birth outcomes enable comparisons of population health attainment across diverse settings. Second, these outcomes are thought to be sensitive to even short-term broad changes in social and economic conditions and health care. Third, birth outcomes signify important lifelong implications for the health, social, and economic outcomes in individuals [13], and IM carries public health significance based on the potential years of life lost (PYLL).

1.2. Within-Country Variations in IM/Birth Outcomes

Wide variations in birth outcomes are also observed within western developed nations. Racial/ethnic disparities in IM are persistent within the USA, with Blacks carrying an excessive burden of infant death that has a significant impact on overall national trends [3,14]. Socioeconomic disparities in birth outcomes are additionally pervasive [15]. Other individual level factors such as maternal health behaviours [16] and psychosocial stress [17] may further contribute to differential pregnancy outcomes.

Disproportionate levels of IM/adverse birth outcomes are present within WE nations. The UK exhibits large variations in IM among different ethnic groups [18,19]. PTB rates vary widely geographically, and are particularly high in the UK's Northern and Trent regions [20]. Differences in PTB rates also exist among ethnic groups in France [21,22] and Germany [23], yet geographical variations in IMR appear to be relatively small [24]. Similar patterns of social inequalities in fetal/perinatal mortality are observed in Nordic countries, although less consistently [25].

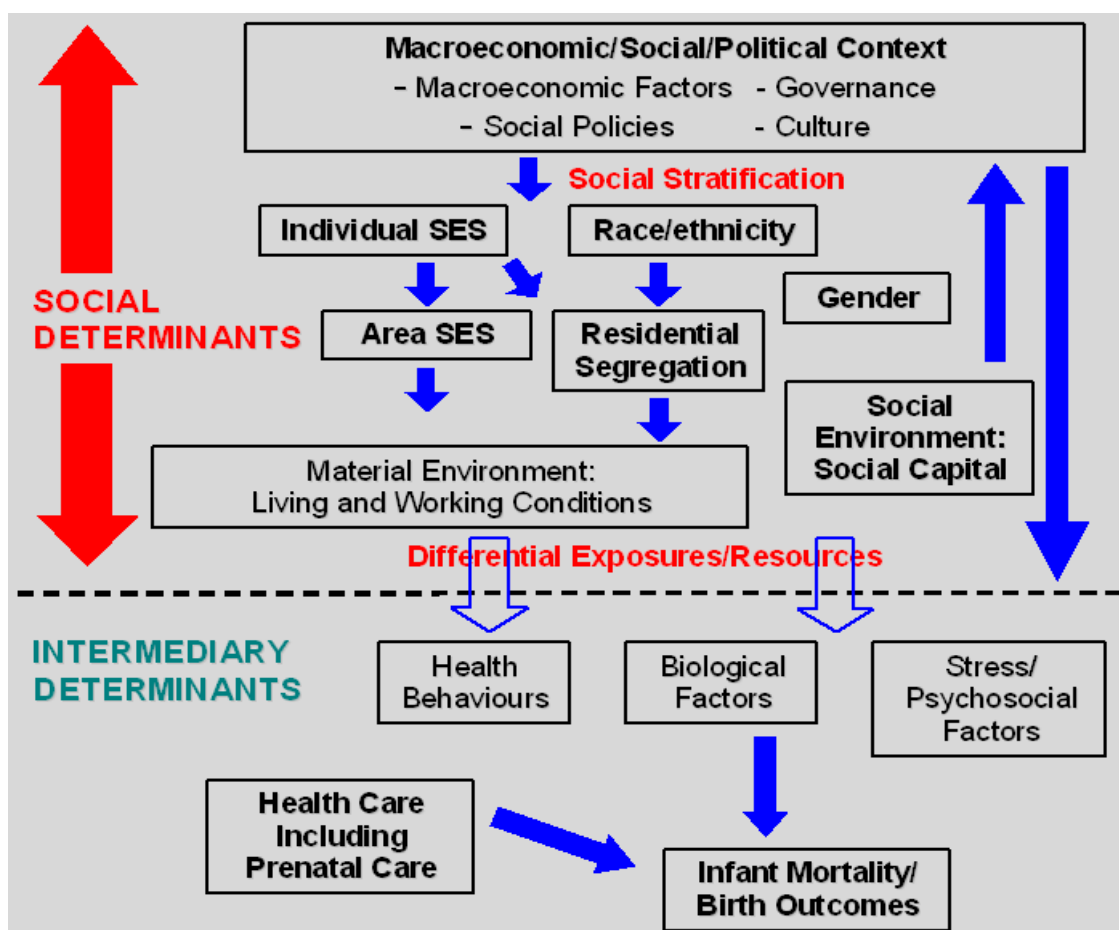
1.3. A Social Determinants of IM/Birth Outcomes Conceptual Framework

To better understand these striking cross-country and within-country patterns, a conceptual framework for the societal to individual level determinants of IM/birth outcomes is needed. In particular, identifying contextual social determinants at the upstream macro level may help to explain the wide variations in IM/birth outcomes *across* countries. Likewise, a social determinant of IM/birth outcomes framework which conceptualises the dynamic interplay between contextual and individual level social determinants with IM/birth outcomes may aid in deciphering patterns of disparities in IM/birth outcomes *within* countries.

Drawing upon work of the World Health Organisation's Commission on Social Determinants of Health [26,27], we offer an adapted conceptual framework with a focus on the hypothesized *social determinants of IM/birth outcomes* (Figure 3). As seen in this figure, the social determinants consist of the *material living and working conditions* and *social environmental conditions in which people are born, live, work, and age*, and the *structural drivers of these conditions*, comprised of individual and area level socioeconomic status (SES), race/ethnicity, residential segregation, gender, social capital/cohesion, and the macroeconomic and macrosocial context, e.g., macroeconomic and social policies including labour market regulations [28], political factors including governance and political rights [29,30], and culture. Macroeconomic determinants include the gross domestic product (GDP) *per capita* and income inequality. The broader macroeconomic and social context generates social stratification *i.e.*, the sorting of people into dominant and subordinate SES, racial/ethnic, and gender

groups (Figure 3). Through stratification and differential exposures of individuals to levels of material factors/social resources, social determinants such as individual/area level SES, race/ethnicity, and social capital shape individual level intermediary determinants, including behavioural factors (e.g., maternal smoking), biological factors, and psychosocial factors (e.g., social support), which in turn produce differential risks of, and inequities in, IM/birth outcomes (Figure 3).

Figure 3. A Social Determinants of IM/Birth Outcomes Conceptual Framework. Adapted from Solar & Irwin [27].



Access to health care and quality of health care are also determinants of these outcomes, but may play lesser roles compared to other societal factors (Figure 3). For example, following Medicaid expansions for pregnant women in the USA, between 1986 and 1993, rates of low birth weight significantly declined among White women of low SES compared to during the preceding period [31]. Other studies have not found that expanding health insurance coverage to uninsured low income pregnant women or earlier initiation of prenatal care is associated with improvements in birth outcomes [32,33]. Furthermore, access to prenatal care may be influenced by social determinants including individual SES and neighborhood material conditions such as access to transportation [34].

While not depicted in the figure, time is an additional inherent element of the framework. That is, each of these social determinants, intermediary determinants, and IM/birth outcomes exists within populations and individuals at specific points in time, and their causal relationships with one another are sensitive to the time that separates them e.g., current neighbourhood (area level) SES influences

future health behaviours at some, but not other, points in time in women over the lifecourse; these behaviours in turn shape future IM/birth outcomes.

2. Methods

2.1. Systematic Literature Review

We systematically reviewed the empirical literature on each of these contextual and individual level social determinants (with the exception of health care) of IM/birth outcomes, within and across western developed nations *i.e.*, USA and WE states. To our knowledge, this represents the first comprehensive review of the social determinants of IM/birth outcomes. We searched PubMed, EmBase, and PsychInfo databases from 1966 to 31 December 2011, using combinations of keywords/subject headings to identify original articles and systematic review articles of birth outcomes and cross-country macroeconomic and macrosocial social determinants, within-country contextual social determinants, and within-country individual level social determinants: “birth outcomes”, “infant mortality”, “fetal mortality”, “neonatal mortality”, “preterm birth”, “low birth weight”, “social determinants”, “gross domestic product”, “income inequality”, “social policies”, “maternity leave”, “neighbourhood deprivation”, “neighbourhood socioeconomic status”, “maternal socioeconomic status”, “race/ethnicity”, “residential segregation”, “social cohesion/capital”, “maternal health behaviour”, “maternal smoking”, “maternal stress/distress”. For the purpose of this systematic review, we focused on non-medical social and economic determinants of birth outcomes, and did not review health care/systems as a social determinant. Recent national and international commissioned reports on the social determinants of health, including by the WHO Commission on the Social Determinants of Health [26] and the Robert Wood Johnson Foundation Commission to Build a Healthier America [35], have likewise placed primary emphasis on non-medical societal determinants across a range of health outcomes. Criteria for inclusion were English-language studies conducted on the USA, UK, Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, and Switzerland. Based on abstracts returned from our search, we reviewed relevant papers, and searched their references for additional papers. We limited our review to studies on the USA and WE states, and excluded studies on developing nations, in order to ensure higher data quality and reduce confounding due to uncontrolled/unmeasured factors. For studies included for each key social determinant, we then noted the observed direction (compared to the hypothesized direction) and statistical significance of findings (using a 5% significance level).

This study addresses a significant gap in the literature to date: that so far there has been insufficient attention paid to the social determinants of IM/birth outcomes as compared to adult health, including in wealthy/industrialized nations. Furthermore, while several systematic reviews of selected social determinants in relation to birth outcomes have been published, no work to date has yet considered them simultaneously. By doing so, we aimed to identify global patterns and gaps in the literature on the social determinants of IM/birth outcomes, and thereby to advance research in these areas. Through promoting understanding of the ways in which societal determinants may facilitate or hinder health and well-being at the very start of life, we may ultimately inform more effective interventions and policies to reduce health inequalities across the lifecourse in the western developed world.

3. Results

For each social determinant, Table 1 classifies studies into the following categories according to their results: significant in the expected direction (positive or inverse, as indicated in Table 1), significant in the opposite direction than expected, mixed (significant and nonsignificant) findings for different indicators of the same construct or for similar outcomes, and null findings. Studies are listed within each category in reverse chronological order.

3.1. Cross-Country Evidence on Macroeconomic and Macrosocial Determinants

3.1.1. Macroeconomic Determinants

Gross Domestic Product (GDP)

Country level economic development, commonly measured using *GDP per capita*, appears to influence IM, at least below a certain threshold or during earlier time periods. Of 140 references returned in our search and the articles cited in relevant publications, three original articles met the inclusion criteria (Table 1). Rodgers [36] demonstrated that *GDP per capita* (reflecting average standards of living for households) is linked ecologically and cross sectionally to IMRs across developing and developed countries, with a curvilinear relationship suggesting diminishing health returns to higher GDP among rich nations. In a time series analysis of high and middle income countries (including the USA, UK, and France) that examined changes in exposures and outcomes (“first difference models”) and thereby reduced confounding, Ensor and colleagues [37] found a modest yet significant inverse association between GDP growth *per capita* and IMRs between 1936 and 1965; this association was absent in more recent time periods (after 1965). Similar patterns among 18 OECD countries were seen by Wennemo [38].

Income Inequality

Of 2,116 references yielded in our search and references cited in relevant abstracts, 14 individual studies (identified through one systematic review and eight other original articles) satisfied the inclusion criteria (Table 1). Income inequality, the distribution of income within populations shaped by macroeconomic policies, may help to account for cross-national variations in IM/birth outcomes. Possible mechanisms include underinvestments in public goods such as health care and education, and the adverse effects of relative deprivation on maternal psychosocial factors. Of 14 epidemiological studies, nine ecological, cross sectional studies with varying degrees of adjustments for country level factors showed significant positive associations between higher income inequality and IMRs in western industrialized nations and across a range of developed and developing countries [38–46]. The other five ecological studies found small, nonsignificant relationships between economic inequality and IMRs [47–51]. For LBW, two of three ecological studies showed positive linkages [40–42].

Table 1. Distribution of studies of the relations between social determinants and IM/birth outcomes, by direction and significance of findings.

Social determinants		Studies with significant findings in expected direction (POS = positive association, INV = inverse association with IM/LBW/PTB)	Studies with significant findings in opposite direction than expected	Studies with mixed findings (significant and nonsignificant)	Studies with null findings	Total number of studies
Cross-country macroeconomic and macrosocial determinants	Gross domestic product *	1 IMR (INV): Rodgers, 1979 [36]	-	2 IMR: Ensor <i>et al.</i> , 2010 [37]; Wennemo, 1993 [38]	-	3 (IMR)
	Income inequality *	9 IMR (POS): Macinko <i>et al.</i> , 2004 [39]; Muntaner <i>et al.</i> , 2002 [40]; Lynch <i>et al.</i> , 2001 [41]; Ruhm, 2000 [42]; Hales <i>et al.</i> , 1999 [43]; McIsaac & Wilkinson, 1997 [44]; Wennemo, 1993 [38]; Waldmann, 1992 [45]; Pampel & Pillai, 1986 [46]	-	-	5 IMR: Leigh <i>et al.</i> , 2007 [47]; Kennelly <i>et al.</i> , 2003 [48]; Wildman <i>et al.</i> , 2003 [49]; Mellor & Milyo, 2001[50]; Judge <i>et al.</i> , 1998 [51]	14 (IMR) 3 (LBW)
		2 LBW (POS): Muntaner <i>et al.</i> , 2002 [40]; Lynch <i>et al.</i> , 2001 [41]			1 LBW: Ruhm, 2000 [42]	
	Social policies *	4 IMR/NMR (INV): Heymann <i>et al.</i> , 2011 [52]; Bradley <i>et al.</i> , 2011 [53]; Filmer & Pritchett, 1999 [54]; Wennemo, 1993 [38]	-	1 IMR/LBW: Pampel & Pillai, 1986 [46]	-	5 (IMR/LBW)

Table 1. Cont.

Social determinants		Studies with significant findings in expected direction (POS = positive association, INV = inverse association with IM/LBW/PTB)	Studies with significant findings in opposite direction than expected	Studies with mixed findings (significant and nonsignificant)	Studies with null findings	Total number of studies
Within-country contextual social determinants	Neighbourhood SES/material conditions	USA (INV): 21 multilevel Janevic <i>et al.</i>, 2010 [55]; Holzman <i>et al.</i>, 2009 [56]; O'Campo <i>et al.</i>, 2008 [57]; Williams <i>et al.</i>, 2007 [58]; Currie & Moretti, 2007 [59]; Masi <i>et al.</i>, 2007 [60]; Farley <i>et al.</i>, 2006 [61]; Grady, 2006 [62]; Messer <i>et al.</i>, 2006 [63]; Subramanian <i>et al.</i>, 2006 [64]; Krieger <i>et al.</i>, 2005 [65]; Reagan <i>et al.</i>, 2005 [66]; Buka <i>et al.</i>, 2003 [67]; Krieger <i>et al.</i>, 2003 [68]; Rich-Edwards <i>et al.</i>, 2003 [69]; Kaufman <i>et al.</i>, 2003 [70]; Pickett <i>et al.</i>, 2002 [71]; Wegner <i>et al.</i>, 2001 [72]; Rauh <i>et al.</i>, 2001 [73]; Fang <i>et al.</i>, 1999 [74] 1 ecological Silva <i>et al.</i>, 2001 [75] WE (INV): 12 multilevel Sundquist <i>et al.</i>, 2011 [76]; Agyemang <i>et al.</i>, 2009 [77]; Sellström <i>et al.</i>, 2007 [78]; Dikken <i>et al.</i>, 2006 [79]; Janghorbani <i>et al.</i>, 2006 [80]; Lasbeur <i>et al.</i>, 2006 [81]; Smith <i>et al.</i>, 2006 [82]; Bundred <i>et al.</i>, 2003 [83]; Aveyard <i>et al.</i>, 2002 [84]; Bonellie, 2001 [85]; Spencer <i>et al.</i>, 1999 [86]; Spencer <i>et al.</i>, 1999 [87] 1 ecological Smith <i>et al.</i>, 2007 [88]	-	USA: 5 multilevel Messer <i>et al.</i>, 2008 [89]; Collins <i>et al.</i>, 2006 [90]; Ahern <i>et al.</i>, 2003 [91]; English <i>et al.</i>, 2003 [92]; Pearl <i>et al.</i>, 2001 [93] 1 ecological Howell <i>et al.</i>, 2005 [94] WE: 2 multilevel Taylor-Robinson <i>et al.</i>, 2011 [95]; Zeitlin <i>et al.</i>, 2011 [96]	USA: 2 multilevel Hillemeier <i>et al.</i>, 2007 [97]; Morenoff <i>et al.</i>, 2003 [98] 2 ecological Young <i>et al.</i>, 2010 [99]; Jaffee & Perloff, 2003 [100] WE: 3 multilevel Calling <i>et al.</i>, 2011 [101]; Clausen <i>et al.</i>, 2006 [102]; Delpisheh <i>et al.</i>, 2006 [103]	USA: 31 WE: 18

Table 1. Cont.

Social determinants		Studies with significant findings in expected direction (POS = positive association, INV = inverse association with IM/LBW/PTB)	Studies with significant findings in opposite direction than expected	Studies with mixed findings (significant and nonsignificant)	Studies with null findings	Total number of studies
Within-country contextual social determinants	Residential segregation	USA (POS): 4 multilevel Debbink & Bader, 2011 [104]; Kramer <i>et al.</i>, 2010 [105]; Walton, 2009 [106]; Bell <i>et al.</i>, 2006 [107] 12 ecological McFarland & Smith, 2011 [108]; Lobmayer & Wilkinson, 2002 [109]; Guest <i>et al.</i>, 1998 [110]; Polednak, 1996 [111]; Bird & Bauman, 1995 [112]; LaVeist, 1993 [113]; Polednak, 1993 [114]; Polednak, 1991 [115]; Laveist, 1990 [116]; LaVeist, 1989 [117]; Yankauer & Allaway, 1958 [118]; Yankauer, 1950 [119]	USA: 2 multilevel Vinikoor <i>et al.</i>, 2008 [120]; Bell <i>et al.</i>, 2006 [107] WE: 2 multilevel Zeitlin <i>et al.</i>, 2010 [96]; Pickett <i>et al.</i>, 2009 [121]	-	USA: 1 multilevel Hearst <i>et al.</i>, 2008 [122]	USA: 19 WE: 2
	Income inequality	USA (POS): 1 multilevel Nkansah-Amankra <i>et al.</i>, 2010 [123] 7 ecological Olson <i>et al.</i>, 2010 (IMR, LBW) [124]; Sohler & Arno, 2003 (IMR) [125]; Lobmayer & Wilkinson, 2002 (IMR) [109]; Ross <i>et al.</i>, 2000 (IMR) [126]; Shi <i>et al.</i>, 1999 (IMR, LBW) [127]; Kennedy <i>et al.</i>, 1996 (IMR) [128]; Kaplan <i>et al.</i>, 1996 (LBW) [129] WE: 1 ecological Materia <i>et al.</i>, 2005 [130]	-	-	USA: 1 multilevel Finch, 2003 [131] 2 ecological Deaton & Lubotsky, 2003 (IMR) [132]; Mellor & Milyo, 2001 (IMR, LBW) [50]	USA: 11 WE: 1
	Social cohesion/ social capital	USA (INV): 1 ecological Kawachi <i>et al.</i>, 1997 [133]	-	USA: 1 multilevel Buka <i>et al.</i>, 2003 [67]	-	USA: 2

Table 1. Cont.

Social determinants		Studies with significant findings in expected direction (POS = positive association, INV = inverse association with IM/LBW/PTB)	Studies with significant findings in opposite direction than expected	Studies with mixed findings (significant and nonsignificant)	Studies with null findings	Total number of studies
Within-country individual level social determinants	Race/ethnicity **	USA (POS for non-White groups vs. Whites): 19 Nabukera <i>et al.</i> , 2009 [134]; Shen <i>et al.</i> , 2008 [135]; Ehrental <i>et al.</i> , 2007 [136]; Kistka <i>et al.</i> , 2007 [137]; Buescher & Mittal, 2006 [138]; Dominguez <i>et al.</i> , 2005 [139]; Dole <i>et al.</i> , 2004 [140]; Rich-Edwards <i>et al.</i> , 2003 [69]; Rosenberg <i>et al.</i> , 2002 [141]; Berg <i>et al.</i> , 2001 [142]; Adams <i>et al.</i> , 2000 [143]; Foster <i>et al.</i> , 2000 [144]; Alexander <i>et al.</i> , 1999 [145]; David & Collins, 1997 [146]; Singh & Yu, 1996 [147]; Schoendorf <i>et al.</i> , 1992 [148]; Abrams & Newman, 1991 [149]; Kleinman & Kessel, 1987 [150]; Shiono & Klebanoff, 1986 [151]	-	USA: 5 Collins <i>et al.</i> , 2004 [156]; Mustillo <i>et al.</i> , 2004 [157]; Rauh, 2001 [73]; Collins <i>et al.</i> , 2000 [158]; Goldenberg <i>et al.</i> , 1998 [159]	USA: 5 Dailey, 2009 [160]; Reagan & Salsberry, 2005 [66]; Korte, 1999 [161]; Shiono <i>et al.</i> , 1997 [162]; Murrell, 1996 [163]	USA: 29 WE: 9
		WE (POS for non-White groups vs. Whites): 8 Reeske <i>et al.</i> , 2011 [152]; Gray <i>et al.</i> , 2009 [18]; Kelly <i>et al.</i> , 2008 [153]; Zeitlin <i>et al.</i> , 2004 [21]; Patel <i>et al.</i> , 2003 [19]; Essén <i>et al.</i> , 2000 [154]; Vangen <i>et al.</i> , 2002 [155]; Zeitlin <i>et al.</i> , 1998 [22]		WE: 1 Aveyard, 2002 [84]		

Table 1. Cont.

Social determinants		Studies with significant findings in expected direction (POS = positive association, INV = inverse association with IM/LBW/PTB)	Studies with significant findings in opposite direction than expected	Studies with mixed findings (significant and nonsignificant)	Studies with null findings	Total number of studies
Within-country individual level social determinants	Individual SES **	USA (INV): 28 Acevedo-Garcia <i>et al.</i> , 2007 [164]; Astone <i>et al.</i> , 2007 [165]; El Reda <i>et al.</i> , 2007 [166]; Williams <i>et al.</i> , 2007 [58]; Masi <i>et al.</i> , 2007 [60]; Colen <i>et al.</i> , 2006 [167]; Farley <i>et al.</i> , 2006 [61]; Goldman <i>et al.</i> , 2006 [168]; Grady, 2006 [62]; Madan <i>et al.</i> , 2006 [169]; Messer <i>et al.</i> , 2006 [170]; Subramanian <i>et al.</i> , 2006 [64]; Acevedo-Garcia <i>et al.</i> , 2005 [171]; Ponce <i>et al.</i> , 2005 [172]; Nicolaidis <i>et al.</i> , 2004 [173]; Savitz <i>et al.</i> , 2004 [174]; Steward & Moser, 2004 [175]; Gould <i>et al.</i> , 2003 [176]; Jaffee, 2003 [100]; Rich-Edwards <i>et al.</i> , 2003 [69]; Pickett <i>et al.</i> , 2002 [71]; Abrevaya, 2001 [177]; Pearl <i>et al.</i> , 2001 [93]; Rauh <i>et al.</i> , 2001 [73]; Rolett & Kiely, 2000 [178]; Shmueli & Cullen, 2000 [179]; Fang <i>et al.</i> , 1999 [74]; Gorman, 1999 [180]	-	USA: 7 Blumenshine <i>et al.</i> , 2011 [193]; Reagan <i>et al.</i> , 2007 [194]; Reagan, 2005 [66]; Finch, 2003 [195]; Braveman <i>et al.</i> , 2001 [196]; Conley & Bennett, 2001 [197]; Parker <i>et al.</i> , 1994 [198]	USA: 9 Currie & Moretti, 2007 [59]; Hillemeier <i>et al.</i> , 2007 [97]; Dominguez, 2005 [139]; Kaufman <i>et al.</i> , 2003 [70]; Morenoff, 2003 [98]; Misra <i>et al.</i> , 2001 [203]; Conley & Bennett, 2000 [197]; Foster <i>et al.</i> , 2000 [144]; Longo <i>et al.</i> , 1999 [204]	USA: 44 WE: 23
		WE (INV): 14 Dibben <i>et al.</i> , 2006 [79]; du Prel <i>et al.</i> , 2006 [181]; Gisselmann, 2006 [182]; Reime <i>et al.</i> , 2006 [183]; Fairley, 2005 [184]; Thompson <i>et al.</i> , 2006 [185]; Spencer <i>et al.</i> , 2004 [186]; Gissler <i>et al.</i> , 2003 [187]; Ronda & Regidor, 2003 [188]; Moser <i>et al.</i> , 2003 [189]; Raum <i>et al.</i> , 2001 [190]; Spencer <i>et al.</i> , 1999 [86]; Ancel <i>et al.</i> , 1999 [191]; Basso <i>et al.</i> , 1999 [192]		WE: 4 Nobile <i>et al.</i> , 2007 [199]; Voight <i>et al.</i> , 2004 [200]; Grimmer <i>et al.</i> , 2002 [201]; Lekea-Karanika <i>et al.</i> , 1999 [202]	WE: 5 Sellström, 2007 [78]; Villalbi <i>et al.</i> , 2007 [205]; Dejin-Karlsson & Ostergren, 2004 [206]; Skórzyńska & Rudnicka-Drozak, 1999 [207]; Vagero <i>et al.</i> , 1999 [208]	

Table 1. Cont.

Social determinants		Studies with significant findings in expected direction (POS = positive association, INV = inverse association with IM/LBW/PTB)	Studies with significant findings in opposite direction than expected	Studies with mixed findings (significant and nonsignificant)	Studies with null findings	Total number of studies
Within-country individual level social determinants	Health behaviours **	USA (POS): <i>6 smoking (prospective)</i> Lobel <i>et al.</i> , 2008 [209]; Orr <i>et al.</i> , 1996 [210]; Doucette & Bracken, 1993 [211]; Shiono <i>et al.</i> , 1986 [212]; van den Berg & Oechsli, 1984 [213]; Frazier <i>et al.</i> , 1961 [214]	-	-	USA: <i>5 smoking (prospective)</i> Siega-Riz <i>et al.</i> , 1996 [221]; Wen <i>et al.</i> , 1990 [222]; Naeye, 1982 [223]; Rush & Kass, 1972 [224]; Yerushalmy, 1964 [225]	USA: 11 WE: 9
		WE (POS): <i>6 smoking (prospective)</i> Wisborg <i>et al.</i> , 1996 [215]; Henriksen <i>et al.</i> , 1995 [216]; Ahlborg & Bodin, 1991 [217]; Stein <i>et al.</i> , 1987 [218]; Obel, 1979 [219]; Russell <i>et al.</i> , 1968 [220]			WE: <i>3 smoking (prospective)</i> Nordentoft <i>et al.</i> , 1996 [226]; Peacock <i>et al.</i> , 1995 [227]; Donovan, 1977 [228]	

Table 1. Cont.

Social determinants		Studies with significant findings in expected direction (POS = positive association, INV = inverse association with IM/LBW/PTB)	Studies with significant findings in opposite direction than expected	Studies with mixed findings (significant and nonsignificant)	Studies with null findings	Total number of studies
Within-country individual level social determinants	Maternal psychosocial factors **	USA (POS): 6 stress (prospective) Glynn <i>et al.</i> , 2008 [229]; Lobel <i>et al.</i> , 2008 [209]; Stinson & Lee, 2003 [230]; Orr <i>et al.</i> , 2002 [231]; Wadhwa <i>et al.</i> , 1993 [232]; Reeb <i>et al.</i> , 1987 [233]	-	-	USA: 4 stress (prospective) Kramer <i>et al.</i> , 2009 [246]; Neggers, 2006 [235]; Strange, 2004 [247]; James, 2000 [248]	USA: 10 stress, 15 depression WE: 7 stress, 7 depression
		6 depression (prospective) Wisner <i>et al.</i> , 2009 [234]; Neggers <i>et al.</i> , 2006 [235]; Jesse <i>et al.</i> , 2003 [236]; Orr <i>et al.</i> , 2002 [231]; Zimmer-Gembeck & Helfand, 1996 [237]; Steer <i>et al.</i> , 1992 [238]			9 depression (prospective) Diego <i>et al.</i> , 2009 [249]; Gavin <i>et al.</i> , 2009 [250]; Li <i>et al.</i> , 2009 [251]; Suri <i>et al.</i> , 2007 [252]; Haas <i>et al.</i> , 2005 [253]; Dole <i>et al.</i> , 2003 [254]; Hoffman & Hatch, 2000 [255]; Copper <i>et al.</i> , 1996 [256]; Perkin <i>et al.</i> , 1993 [257]	
		WE (POS): 4 stress (prospective) Class <i>et al.</i> , 2011 [239]; Martini <i>et al.</i> , 2010 [240]; Khashan <i>et al.</i> , 2009 [241]; Hedegaard <i>et al.</i> , 1996 [242]			WE: 3 stress (prospective) Krabbendam <i>et al.</i> , 2005 [258]; Nordentoft <i>et al.</i> , 1996 [226]; Henriksen <i>et al.</i> , 1994 [259]	
		3 depression (prospective) Dayan <i>et al.</i> , 2006 [243]; Dayan <i>et al.</i> , 1999 [244]; Hedegaard <i>et al.</i> , 1993 [245]			4 depression (prospective) Elsenbruch <i>et al.</i> , 2007 [260]; Berle <i>et al.</i> , 2005 [261]; Andersson <i>et al.</i> , 2004 [262]; Nordentoft <i>et al.</i> , 1996 [226]	

* All ecological studies. ** All individual level studies. Statistical significance was defined by a *p* value <0.05 (where reported).

3.1.2. Macrosocial Determinants

Social Policies

Of 1,665 references and articles cited, five original articles were included in our review (Table 1). Social policies, particularly those structuring maternal leave programs, may be key determinants of IM/birth outcomes through improving the quality of prenatal care and adult care to neonates/infants [52]. In the USA, working women are entitled to ≥ 12 weeks of *unpaid* maternity leave through the 1993 Family and Medical Leave Act [263]. By contrast, WE countries have implemented *paid* maternity leave policies since 1945. In WE countries, paid maternity leave ranges from a maximum of 14 weeks in Germany and Switzerland to approximately 77 weeks in Sweden [2]. Contemporary policies aim to prevent PTB by granting women time off and offering generous financial compensation (90–100% of salary). The initiation of maternity leave varies by WE country: 6–8 weeks pre-delivery in France and Germany, 10 weeks pre-delivery in Sweden, and 12 weeks pre-delivery in the UK. Financial compensation of salary during maternity leave is likewise generous: women are compensated at 100% in France and Germany, and at 90% in Sweden and Denmark. Countries such as France have achieved improvements in maternity leave policies and documented downward trends in PTB rates over the past 30 years, although it is difficult to show a causal link between the two because population wide policies eliminate the possibility of controls for evaluation [264]. Nevertheless, a recent cross-national, cross sectional study among 141 OECD and non OECD countries found that an increase of 10 weeks of paid maternal leave predicted 10% significantly lower NMRs and IMRs, controlling for important covariates [52].

Government spending on non-health factors, and to a lesser extent on health factors, may also help to account for cross-country variations in IMRs. In a pooled cross sectional analysis adjusting for multiple country level factors, total government spending (medical care, public health, social welfare) was significantly inversely associated with post-neonatal mortality rates (for deaths 29 days to one year of age), but not NMRs [46]. In a recent cross sectional study, Bradley and colleagues [53] found that the ratio of social to health expenditures was significantly protective against IMRs, controlling for GDP *per capita*. Two other investigations, including one that used instrumental variable analysis, also supported a greater role of non-health *versus* health spending [38,54].

3.2. Within-Country Evidence on Contextual Social Determinants

3.2.1. Neighbourhood SES/Material Conditions

Based on 513 references and articles cited in relevant papers, 49 studies (31 USA, 18 WE studies, identified through one systematic review and 11 other original articles) met the inclusion criteria (Table 1).

USA. Neighbourhood level socioeconomic deprivation may partially account for variations in USA pregnancy outcomes through enabling women's access to material resources and services. We identified 31 studies of neighbourhood SES and birth outcomes in the USA (Table 1). The majority of studies (21 of 31) found significant associations between a neighbourhood SES indicator or index (*i.e.*, neighbourhood and area level income, poverty, education, employment, occupation, housing, and

residential stability) and an adverse birth outcome (*i.e.*, PTB and/or LBW) (Table 1). Significant positive associations in five studies were specific to a racial/ethnic subgroup [55,63,70,71,74]. Meanwhile, only five [55,59,66,67,71] of the 31 studies analyzed data from a prospective/retrospective cohort, all of which had significant findings, while the majority of studies used cross sectional designs; four studies were ecological [75,94,99,100]. All studies adjusted for age, and all five cohort studies controlled for parental SES and race/ethnicity either through statistical adjustment or stratification. No studies in the literature have yet examined the associations between availability of specific material goods/services within neighbourhoods and IM/birth outcomes.

WE. Neighbourhood socioeconomic deprivation also appears to determine birth outcomes in Western Europe. We identified 18 studies of neighbourhood SES and IM/birth outcomes (Table 1). Most (13 of 18) studies found significant associations between neighbourhood SES and IM/birth outcomes. Six [76,83,87,95,101,102] of the 18 studies analyzed prospective/retrospective cohort data, of which three studies had significant findings [76,85,86]. Eleven studies used cross sectional study designs [77–84,86,96,103] and one study was ecological [88]. All studies adjusted for age. However, only one study [84] in countries with ethnically heterogeneous populations controlled for both parental SES and race/ethnicity.

3.2.2. Residential Segregation

Of 35 references and articles cited in those publications, 21 individual studies (19 USA, two WE) were included (Table 1).

USA. Residential segregation, defined as the extent to which social groups characterized by income or race/ethnicity are spatially separated from one another, may also contribute to IM/birth outcome disparities through the effects of harmful material and psychosocial environments within segregated communities. In an ecological analysis, residential segregation *by income* was positively related to IMRs, independent of mean household income and metropolitan area income inequality [109]. To date, all 12 ecological studies on residential segregation *by race/ethnicity* have found associations with higher IM/PTB risks [108–119]. Of seven multilevel, multivariate studies, four studies observed significant associations for racial segregation among Blacks [104–107]. Another multilevel analysis used propensity score methods to reduce confounding, and found no effect of racial segregation on IM [122]. Two other studies identified protective associations for racial segregation [107,120]. Living in racially homogeneous neighbourhoods may protect against IM/birth outcomes through the “ethnic density effect”, *i.e.*, the benefits from residing in a neighbourhood containing same-ethnic individuals as oneself, possibly through political empowerment and social cohesion (as indicated by the arrow going from residential segregation to the social environment/social capital in Figure 3) [107,120].

WE. Racial/ethnic segregation levels are generally lower in European cities than USA cities [73]. This may account for the lack of investigation of impacts of residential segregation on IM/birth outcomes in WE nations. The closest related (though not synonymous) concept studied in WE is same-ethnic density. In two multilevel, cross-sectional studies, same-ethnic density had marginally protective associations against PTB for foreign-born (but not native) women in France [96] and for Pakistani women (but not women of other ethnicities) in the UK [121], possibly through the ethnic density effect.

3.2.3. Income Inequality

Of 2,116 references and articles cited in relevant papers, 12 studies (11 USA, one WE original articles) satisfied our inclusion criteria (Table 1).

USA. Six [109,124–128] of 8 ecological, cross sectional studies [50,109,124–128,132] on state/metropolitan area income inequality and IMRs that primarily adjusted for area level income showed significant positive relationships; three [124,127,129] of four studies [50,124,127,129] on income inequality and LBW found positive associations. Only two studies have been multilevel: higher neighbourhood level income was linked to a higher individual risk of LBW for Blacks, independent of maternal income [123]. Controlling for state and individual level covariates, Finch [131] found no independent effect of state level income inequality on the individual probability of IM.

WE. Few studies in WE have examined the associations between income inequality and IM/birth outcomes. One ecological study in Italy observed a positive relation between the provincial Gini coefficient and IMRs [130].

3.2.4. Social Cohesion/Social Capital

Of 13 references and articles cited in those publications, two original articles (both from the USA) were included in the review (Table 1).

USA. The degrees of social support, trust, networks, and connectedness characterizing a neighbourhood or community are referred to as stocks of social capital/cohesion [265], and could influence health through social support, diffusion of knowledge on healthy behaviours, and/or collective action leading to policies that provide health promoting public goods [266]. In an ecological, cross sectional study, lower state level social capital (trust, associational memberships) was strongly linked to higher IMRs in Blacks [133]. In a multilevel, cross sectional analysis, low perceived neighbourhood cohesion predicted lower infant birth weight among Blacks but not Whites [67].

WE. There is a dearth of research on social cohesion and infant health in WE nations, such that no studies were identified on this topic.

3.3. Within-Country Evidence on Individual Level Social Determinants

3.3.1. Race/Ethnicity

Of 91 references and articles cited, 38 articles (29 USA and nine WE studies, identified through two systematic reviews and 17 other original articles) met the inclusion criteria (Table 1).

USA. Recent USA data shows a more than two-fold difference between non-Hispanic Blacks and non-Hispanic Whites for the IMR (12.7 vs. 5.5 deaths per 1,000 live births), NMR (9.0 vs. 3.6), FMR (11.1 vs. 4.8), and PMR (12.3 vs. 5.6) [6,226,259]. These racial/ethnic disparities have been framed through a variety of socioeconomic, behavioural, biological, and genetic explanatory lenses [267–269]. Race may also determine IM/birth outcomes through racial residential segregation. Nineteen of 29 USA-based studies have found positive linkages between race/ethnicity and VPTB or VLBW after adjusting for individual level factors (Table 1). Other research identifies certain antecedents of PTB (e.g., maternal age, multiple gestation births) and LBW (e.g., unhealthy lifestyle behaviours,

inadequate prenatal care) as contributing factors to racial/ethnic disparities [270]. However, even in low risk populations, there is strong evidence for racial/ethnic variation in birth outcomes [144,145]. Racial discrimination may further play a role. In a recent systematic review of 10 studies of racial discrimination and risks of PTB, LBW, and VLBW, Giurgescu *et al.* [271] found three studies with positive and significant associations, three studies with mixed significant and nonsignificant findings, and four studies with null associations.

WE. Increases in migration to WE nations in recent decades have affected birth outcomes of ethnic populations. The risks of fetal, neonatal, and infant mortality are generally higher among refugees and non-refugee migrants than non migrants, although these patterns vary by country of origin and receiving country [272]. Findings from three UK studies suggest that women from certain ethnic groups (e.g., Black African, Black Caribbean, Asian, Indian, Pakistani, and Bangladeshi) have higher adjusted risks of adverse birth outcomes than White women [26,27,153]. French women of Afro-Caribbean origin experience the highest PTB rates [29] and those of Sub Saharan African origin have the greatest odds of perinatal mortality [30]. Migrants from the Middle East and North Africa (including Turkey) in Germany have significantly higher risks of fetal death than non-migrants [152]. Foreign born women in Nordic countries have relatively higher adjusted risks of perinatal mortality [154], higher FMRs, and poorer birth outcomes [155].

3.3.2. Individual SES

Of 1,808 references and articles cited in relevant papers, 67 studies (44 USA and 23 WE studies, identified through one systematic review and three other original articles) were included in our review (Table 1).

USA. Parental SES may account for variations in IM/birth outcomes by shaping access to instrumental resources for adopting healthy practices and avoiding harmful risks; it also sorts individuals into different socioeconomic environments e.g., neighbourhoods of residence. We identified 44 American studies of parental SES and birth outcomes (Table 1). Twenty eight of these studies found significant inverse associations between ≥ 1 socioeconomic indicator and an adverse birth outcome, although in 11 studies the associations were specific to a population subgroup. Of the 44 studies, only 10 studies [59,66,70,139,144,165,167,174,194,197] (three with significant findings; [165,167,174]) used data from a prospective cohort, while the remainder of studies employed case-control or cross sectional study designs. All but one cohort study [194] adjusted for age, while all but two studies [139,165] controlled for race/ethnicity.

WE. Parental SES is also a key predictor of birth outcomes in WE nations. We identified 23 studies of parental SES and birth outcomes (Table 1). Fourteen of the studies observed significant associations. Twenty studies relied on case-control or cross sectional study designs, whereas only three studies [86,190,206] were based on a prospective cohort, with significant findings in two studies [86,190]. Two of the three cohort studies adjusted for maternal age [190,206]; one [190] of two cohort studies [86,190] in countries with ethnic heterogeneity controlled for race/ethnicity. For IM, a systematic review of studies published between 1980 and 2000 suggests that SES inequalities exist across Nordic countries [273]; other Nordic studies support SES linkages to IM [101,274,275].

3.3.3. Health Behaviours

Of 1,902 references and articles cited in relevant papers, 20 prospective studies on maternal smoking and birth outcomes (11 USA and nine WE studies, identified through one systematic review) met the inclusion criteria (Table 1).

USA. Preconception health behaviours (e.g., healthy eating, regular exercise) may protect against adverse birth outcomes, while other behaviours (e.g., smoking, alcohol misuse, and inadequate intake of folic acid) may contribute to them [91]. Maternal smoking, a key prevalent modifiable risk factor during pregnancy, has been previously investigated in association with PTB in 64 studies [16]. Of 11 USA based prospective studies controlling for covariates including age, race/ethnicity, and income, six studies linked maternal smoking to significantly higher PTB odds, while findings in the other five studies were null. Evidence suggests that a low glycemic Mediterranean-type diet during pregnancy may decrease PTB risk [276]. Periconceptional multivitamin use has also been significantly inversely linked to the risk of PTB [277]. However, few high-quality studies to date have explored the roles of nutrient deficiencies in PTB [278].

WE. The implications of poor maternal health behaviours likewise apply within WE countries. In the UK, maternal obesity has been associated with significantly higher risks of IM [279] and adverse birth outcomes [280]. Other UK studies highlight the association between alcohol consumption and early fetal death [281]. For smoking, of nine WE-based prospective studies, six studies found that maternal smoking predicts significantly higher PTB odds [16].

3.3.4. Maternal Psychosocial Factors

Of 930 references and the articles cited in those publications, 39 articles (25 USA and 14 WE studies, identified through two systematic reviews) were included (Table 1).

USA. Maternal psychosocial factors may be important determinants of birth outcomes, plausibly acting through behavioural or direct physiologic pathways [17,282]. Differential levels of stress during pregnancy may contribute to disparities in perinatal health [283]. In six of 10 prospective USA studies, the multivariate adjusted relations between stress during pregnancy and PTB/LBW were significantly positive [17,209,229–233]. In a meta-analysis of 15 American prospective studies of depression during pregnancy and birth outcomes (14 studies of PTB and six studies of LBW, with six of 15 studies showing significant associations for PTB/LBW overall), Grote *et al.* [282] found significant yet modest summary adjusted relative risks (RRs) of 1.10 between antenatal depression and risks of each of PTB and LBW.

WE. Maternal distress and anxiety can independently contribute to adverse fetal and neonatal outcomes [284]. Of seven WE studies on the prospective relationships between antenatal psychosocial stress and PTB/LBW, four studies found significant positive associations [17,239–242]. In a meta-analysis of seven prospective studies of depression during pregnancy and birth outcomes (five PTB and three LBW studies, with three of seven studies showing significant associations for PTB/LBW overall), there were significant and nonsignificant summary RRs of 1.37 and 1.16 between antenatal depression and PTB and LBW, respectively [282].

4. Discussion

This paper focused on key indicators of population health at the very onset of life—IM and birth outcomes—reflecting short term and wide ranging changes in societal conditions, indicators that can signify profound social and economic sequelae over the life course for individuals and populations. To explain patterns of IM/birth outcome variations across and within western developed countries, we conceptualized a framework and conducted systematic reviews of the empirical literature on the social determinants of IM/birth outcomes, spanning determinants from the societal down to the individual level. Unlike previous systematic reviews, we considered these social determinants and intermediary factors simultaneously to identify more general patterns and gaps that characterize this literature.

Consistent with the well known curvilinear relationship between GDP and life expectancy—the Preston curve [285]—with diminishing health returns to higher GDP among rich nations, the limited evidence to date suggests GDP *per capita* may play a modest role in explaining current IM/birth outcome variations across the western developed world. Meanwhile, the epidemiological literature provides support for other macroeconomic/societal conditions as more important explanatory factors. For instance, nearly two-thirds of income inequality studies have found linkages with IM/birth outcomes, although these studies have been largely ecological and cross sectional in design. Likewise, in ecological cross sectional studies, paid maternal leave policies, levels of social spending, and ratios of social to health spending have all been found to predict IMRs in the hypothesized directions.

Within both the USA and WE countries, the evidence in roughly two-thirds of studies suggests that neighbourhood SES is a determinant of adverse birth outcomes. However, most of these studies have been cross sectional rather than prospective. Furthermore, no studies have yet explored whether specific neighbourhood material goods and services may be related to IM/birth outcomes; such analyses could help to unpack the specific mechanisms for the effects of neighbourhood SES. Most studies on residential segregation by race/ethnicity in the USA show positive findings, although have been largely ecological in design; multilevel studies which account for individual level factors exhibit more mixed findings. In WE countries, the presence of lower levels of residential segregation may account for the lack of investigation of segregation in those settings; the limited evidence to date supports a health-protective ethnic density effect of segregation. Meanwhile, social cohesion/capital has been relatively underexplored as a predictor of birth outcomes. The few published studies in the USA support a relationship, while no studies have yet been conducted on social cohesion/capital and IM/birth outcomes within WE countries. Like for neighbourhood SES, studies on individual SES have found primarily inverse associations with IM/birth outcomes, but the majority of studies have likewise been cross sectional. For other individual level social determinants, associations have been relatively mixed for race/ethnicity and selected intermediary behavioural and psychosocial factors (e.g., smoking, maternal stress and depression).

Adopting a social determinants of IM/birth outcomes conceptual framework and jointly examining the empirical evidence on these social determinants further suggests several conceptual and methodological gaps in the literature. First, our framework highlights multiple levels of social determinants, the presence of multiple factors at each level, and the importance of stratification by SES, race/ethnicity, and gender [26,27] to the production of inequities in IM/birth outcomes. Studies and reviews to date have presented, either explicitly or implicitly, generally more simplified

conceptual frameworks. While a number of studies of contextual social determinants (e.g., neighbourhood SES) have incorporated a multilevel structure, as we note above, many other studies have been ecological; even in multilevel studies, there have been varying levels of adjustment for key compositional factors such as parental SES and race/ethnicity, and other social determinants at the same or higher spatial levels (e.g., social cohesion, social policies). As with other observational studies in which exposures do not vary randomly [286], concerns are raised about the presence of true associations *versus* spurious associations due to residual confounding. In future investigations, statistical models should attempt to specify other social determinants at multiple levels. Furthermore, this literature would benefit from the growing arsenal of novel analytical approaches to improve causal inference, such as instrumental variable analysis [266], propensity score methods [287], and marginal structural models [288].

Second, because social stratification leads to differential exposures to social determinants, and thereby to material conditions and psychosocial resources, some demographic and socioeconomic population groups may exhibit stronger associations for social determinants with health outcomes than other groups [289]. Yet apart from race/ethnicity (in studies of area level SES effects), compositional factors such as maternal age, SES, and rural/urban status have largely been ignored as possible effect modifiers in studies to date. By identifying such effect modifiers, future interventions and policies could be tailored towards vulnerable population groups [290], and could potentially lead to more effective reductions in IM/birth outcome disparities.

Third, among the cross-country and within-country contextual social determinants that we reviewed, nearly two-thirds (64.2%) of investigations have focused on factors at the neighbourhood level (SES, residential segregation). Critically, studies of macroeconomic and macrosocial factors at higher geographical levels than neighbourhoods comprise only about one-third (35.8%) of studies on contextual social determinants. Better understanding the social determinants of IM/birth outcome disparities and better addressing these inequities will require in depth research and attention to these most fundamental “causes of causes” of health and disease [26,291].

Notably, our study was limited in several respects. As indicated earlier, it excluded the literature on a wider set of countries, including developing nations which are characterized by a higher burden of IM/adverse birth outcomes. This exclusion was to reduce potential residual confounding, although at the price of reduced generalisability. In addition, we did not perform a meta-analysis or other quantitative analysis, in light of the heterogeneity of effect size measures, presence of cross sectional designs, and lack of adjustment for important confounders in many studies, as well as insufficient numbers of studies for some social determinants (e.g., GDP, social capital) that reduced our confidence in the validity of summary estimates [292]. We instead relied on systematic reviews to attempt to identify more general qualitative patterns for each social determinant, and patterns across social determinants. Finally, as stated at the outset, we did not examine health care/systems as a social determinant, and focused our systematic review on non-medical social and economic determinants of IM/birth outcomes.

5. Conclusions

In keeping with the recent Adelaide Statement on Health in All Policies [293], at a societal level, both health and non-health policies that address the social determinants of health are needed to tackle IM/birth outcome disparities [294]. Implementing such policies while addressing key research gaps for the social determinants of IM/birth outcomes may optimally reduce inequities in these vital health outcomes across and within the western industrialized world.

Acknowledgements

Daniel Kim is supported by a career development Pathway to Independence Award through the National Heart, Lung, and Blood Institute of the U.S. National Institutes of Health (grant R00 HL089459).

Conflicts of Interest

The authors declare no conflict of interest.

References

1. World Bank. World Development Indicators: Level & Trends in Child Mortality. Report 2010. Available online: <http://data.worldbank.org/indicator/SH.DYN.MORT> (accessed on 1 November 2012).
2. Organization for Economic Co-operation and Development (OECD). *OECD Family Database*; OECD: Paris, France, 2011.
3. MacDorman, M.F.; Mathews, T.J. NCHS data brief: Recent trends in infant mortality in the United States. *Natl. Center Health Stat.* **2008**, *9*, 1–8.
4. MacDorman, M.F.; Hoyert, D.L.; Martin, J.; Munson, M.L.; Hamilton, B.E. Fetal and perinatal mortality, United States, 2003. *Natl. Vital Stat. Reports* **2007**, *55*, 1–20.
5. *Neonatal and Perinatal Mortality: Country, Regional, and Global Estimates*; World Health Organization: Geneva, Switzerland, 2006.
6. Mathews, T.J.; MacDorman, M.F. Infant mortality statistics from the 2006 period linked birth/infant death data set. *Natl. Vital Stat. Reports* **2010**, *58*, 1–32.
7. Beck, S.; Wojdyla, D.; Say, L.; Betran, A.P.; Merialdi, M.; Requejo, J.H.; Rubens, C.; Menon, R.; van Look, P.F.A. The worldwide incidence of preterm birth: A systematic review of maternal mortality and morbidity. *Bull. WHO* **2010**, *88*, 31–38.
8. Lawn, J.E.; Gravett, M.G.; Nunes, T.M.; Rubens, C.E.; Cynthia, S.; GAPPS Review Group. Global report on preterm birth and stillbirth (1 of 7): Definitions, description of the burden and opportunities to improve data. *BMC Pregnancy Childbirth* **2010**, *10* (Suppl. 1), S1, doi: 10.1186/1471-2393-10-S1-S1.
9. UNICEF. *Low Birth Weight: Country, Regional, and Global Estimates*; United Nations Children's Fund and World Health Organization: New York, NY, USA, 2004.
10. Hamilton, B.E.; Martin, J.A.; Ventura, S.J. Births: Preliminary data for 2009. *Natl. Vital Stat. Reports* **2010**, *59*, 1–19.

11. OECD. Health at a Glance: Europe 2010. Available online: http://dx.doi.org/10.1787/health_glance-2010-en (accessed on 1 November 2012).
12. Conley, D.; Springer, K.W. Welfare state and infant mortality. *Am. J. Sci.* **2001**, *107*, 768–807.
13. Odd, D.E.; Gunnell, D.; Lewis, G.; Rasmussen, F. Long-term impact of poor birth condition on social and economic outcomes in early adulthood. *Pediatrics* **2011**, *127*, e1498–e1504.
14. Centers for Disease Control and Prevention. Infant mortality and low birth weight among Black and White infants—United States, 1980–2000. *MMWR* **2002**, *51*, 589–592.
15. Blumenshine, P.; Egerter, S.; Barclay, C.J.; Cubbin, C.; Braveman, P.A. Socioeconomic disparities in adverse birth outcomes: A systematic review. *Am. J. Prev. Med.* **2010**, *39*, 263–272.
16. Shah, N.R.; Bracken, M.B. A systematic review and meta-analysis of prospective studies on the association between maternal cigarette smoking and preterm delivery. *Am. J. Obstetr. Gyn.* **2010**, *182*, 465–472.
17. Littleton, H.L.; Bye, K.; Buck, K.; Amacker, A. Psychosocial stress during pregnancy and perinatal outcomes: A meta-analytic review. *J. Psychosom. Obstetr. Gyn.* **2010**, *31*, 219–228.
18. Gray, R.; Headley, J.; Oakley, L.; Kurinczuk, J.J.; Brocklehurst, P.; Hollowell, J. *Inequalities in Infant Mortality Project Briefing Paper 3. Towards an Understanding of Variations in Infant Mortality Rates between Different Ethnic Groups*; National Perinatal Epidemiology Unit: Oxford, UK, 2009.
19. Patel, R.; Steer, P.; Doyle, P.; Little, M.P.; Elliott, P. Does gestation vary by ethnic group? A London-based study of over 122,000 pregnancies with spontaneous onset of labour. *Int. J. Epi.* **2003**, *33*, 107–113.
20. Field, D.; Draper, E.S.; Fenton, A.; Papiernik, E.; Zeitlin, J.; Blondel, B.; Cuttini, M.; Maier, R.F.; Weber, T.; Carrapato, M.; *et al.* Rates of very preterm birth in Europe and neonatal mortality rates. *Arch. Dis. Child. Fetal Neonatal. Ed.* **2009**, *94*, F253–F256.
21. Zeitlin, J.; Bucourt, M.; Rivera, L.; Topuz, B.; Papiernik, E. Preterm birth and maternal country of birth in a French district with a multiethnic population. *Br. J. Obstetr. Gyn.* **2004**, *111*, 849–855.
22. Zeitlin, J.; Combier, E.; De Caunes, F.; Papiernik, E. Socio-demographic risk factors for perinatal mortality: A study of perinatal mortality in the French district of Seine-Saint-Denis. *Acta Obstetr. Gyn. Scand.* **1998**, *77*, 826–835.
23. David, M.; Pachaly, J.; Vetter, K. Perinatal outcome in Berlin (Germany) among immigrants from Turkey. *Arch. Gyn. Obstetr.* **2006**, *274*, 271–278.
24. Fantini, M.P.; Stivanello, E.; Dallolio, L.; Loghi, M.; Savoia, E. Persistent geographical disparities in infant mortality rates in Italy (1999–2001): Comparison with France, England, Germany, and Portugal. *Eur J Public Health* **2005**, *16*, 429–432.
25. Jørgensen, T.; Mortensen, L.H.; Anderson, A.M. Social inequality in fetal and perinatal mortality in the Nordic countries. *Scand. J. Public Health* **2008**, *36*, 635–649.
26. Commission on Social Determinants of Health. *Closing the Gap in a Generation: Health Equity through Action on the Social Determinants of Health. Final Report of the Commission on Social Determinants of Health*; World Health Organization: Geneva, Switzerland, 2008.
27. Solar, O.; Irwin, A. *A Conceptual Framework for Action on the Social Determinants of Health. Discussion Paper for the Commission on Social Determinants of Health*; World Health Organization: Geneva, Switzerland, 2007.

28. Muntaner, C.; Chung, H.; Benach, J.; Ng, E. Hierarchical cluster analysis of labour market regulations and population health: A taxonomy of low- and middle-income countries. *BMC Public Health* **2012**, *12*, 286, doi: 10.1186/1471-2458-12-286.
29. Chung, H.; Muntaner, C. Political and welfare state determinants of infant and child health indicators: An analysis of wealthy countries. *Soc. Sci. Med.* **2006**, *63*, 829–842.
30. Bezo, B.; Maggi, S.; Roberts, W.L. The rights and freedoms gradient of health: Evidence from a cross-national study. *Front. Psychol.* **2012**, *3*, 441, doi: 10.3389/fpsyg.2012.00441.
31. Dubay, L.; Joyce, T.; Kaestner, R.; Kenney, G.M. Changes in prenatal care timing and low birth weight by race and socioeconomic status: Implications for the Medicaid expansions for pregnant women. *Health Serv. Res.* **2001**, *36*, 373–398.
32. Haas, J.S.; Udvarhelyi, I.S.; Morris, C.N.; Epstein, A.M. The effect of providing health coverage to poor uninsured pregnant women in Massachusetts. *JAMA* **1993**, *269*, 87–91.
33. Hueston, W.J.; Gilbert, G.E.; Davis, L.; Sturgill, V. Delayed prenatal care and the risk of low birth weight delivery. *J. Community Health* **2003**, *28*, 199–208.
34. Phillippi, J.C. Women's perceptions of access to prenatal care in the United States: A literature review. *J. Midwifery Womens Health* **2009**, *54*, 219–225.
35. Robert Wood Johnson Foundation Commission to Build a Healthier America. *Beyond Health Care: New Directions to a Healthier America*; Robert Wood Johnson Foundation: Princeton, NJ, USA, 2009.
36. Rodgers, G.B. Income inequality as determinants of mortality: An international cross section analysis. *Pop. Studies* **1979**, *33*, 343–351.
37. Ensor, T.; Cooper, S.; Davidson, L.; Fitzmaurice, A.; Graham, W.J. The impact of economic recession on maternal and infant mortality: Lessons from history. *BMC Public Health* **2010**, *10*, 727, doi: 10.1186/1471-2458-10-727.
38. Wennemo, I. Infant-mortality, public policy, and inequality—A comparison of 18 industrialized countries 1950–85. *Soc. Health Illness* **1993**, *15*, 429–446.
39. Macinko, J.; Shi, L.; Starfield, B. Wage inequality, health care, and infant mortality in 19 industrialized countries. *Soc. Sci. Med.* **2004**, *58*, 279–292.
40. Muntaner, C.; Lynch, J.W.; Hillemeier, M.; Lee, J.H.; David, R.; Benach, J.; Borrell, C. Economic inequality, working class power, social capital, and cause-specific mortality in wealthy countries. *Int. J. Health Services* **2002**, *32*, 629–656.
41. Lynch, J.W.; Smith, G.D.; Hillemeier, M.; Shaw, M.; Raghunathan, T.; Kaplan, G.A. Income inequality, the psychosocial environment, and health: Comparisons of wealthy nations. *Lancet* **2001**, *358*, 194–200.
42. Ruhm, C.J. Parental leave and child health. *J. Health Econ.* **2000**, *19*, 931–960.
43. Hales, S.; Howden-Chapman, P.; Salmond, C.; Woodward, A.; Mackenbach, J. National infant mortality rates in relation to gross national product and distribution of income. *Lancet* **1999**, *354*, 2047, doi: 10.1016/S0140-6736(99)03763-0.
44. McIsaac, S.; Wilkinson, R.G. Income distribution and cause-specific mortality. *Eur. J. Public Health* **1997**, *7*, 45–53.
45. Waldmann, R.J. Income-distribution and infant-mortality. *Quart. J. Econ.* **1992**, *107*, 1283–1302.

46. Pampel, F.C.; Pillai, V.K. Patterns and determinants of infant mortality in developed nations, 1950–1975. *Demography* **1986**, *23*, 525–542.
47. Leigh, A.; Jencks, C. Inequality and mortality: Long-run evidence from a panel of countries. *J. Health Econ.* **2007**, *26*, 1–24.
48. Kennelly, B.; O’Shea, E.; Garvey, E. Social capital, life expectancy and mortality: A cross-national examination. *Soc. Sci. Med.* **2003**, *56*, 2367–2377.
49. Wildman, J.; Gravelle, H.; Sutton, M. Health and income inequality: Attempting to avoid the aggregation problem. *Applied Econ.* **2003**, *35*, 999–1004.
50. Mellor, J.M.; Milyo, J. Reexamining the evidence of an ecological association between income inequality and health. *J. Health Politics Policy Law* **2001**, *26*, 487–522.
51. Judge, K.; Muligan, J.A.; Benzeval, M. Income inequality and population health. *Soc. Sci. Med.* **1998**, *46*, 567–579.
52. Heymann, J.; Raub, A.; Earle, A. Creating and using new data sources to analyze the relationship between social policy and global health: The case of maternal leave. *Public Health Rep.* **2011**, *126* (Suppl. 3), 127–134.
53. Bradley, E.H.; Elkins, B.R.; Herrin, J.; Elbel, B. Health and social services expenditures: Associations with health outcomes. *BMJ Qual. Saf.* **2011**, *20*, 826–831.
54. Filmer, D.; Pritchett, L. The impact of public spending on health: Does money matter? *Soc. Sci. Med.* **1999**, *49*, 1309–1323.
55. Janevic, T.; Stein, C.R.; Savitz, D.A.; Kaufman, J.S.; Mason, S.M.; Herring, A.H. Neighbourhood deprivation and adverse birth outcomes among diverse ethnic groups. *Ann. Epidemiol.* **2010**, *20*, 445–451.
56. Holzman, C.; Eyster, J.; Kleyn, M.; Messer, L.C.; Kaufman, J.S.; Laraia, B.A.; O’Campo, P.; Burke, J.G.; Culhane, J.; Elo, I.T. Maternal weathering and risk of preterm delivery. *Am. J. Public Health* **2009**, *99*, 1864–1871.
57. O’Campo, P.; Burke, J.G.; Culhane, J.; Elo, I.T.; Eyster, J.; Holzman, C.; Messer, L.C.; Kaufman, J.S.; Laraia, B.A. Neighbourhood deprivation and preterm birth among non-Hispanic Black and White women in eight geographic areas in the United States. *Am. J. Epidemiol.* **2008**, *15*, 155–163.
58. Williams, B.L.; Pennock-Roman, M.; Suen, H.K.; Magsumbol, M.S.; Ozdenerol, E. Assessing the impact of the local environment on birth outcomes: A case for HLM. *J. Expo. Sci. Environ. Epidemiol.* **2007**, *17*, 445–457.
59. Currie, J.; Moretti, E. Biology as destiny? Short- and long-run determinants of intergenerational transmission of birth weight. *J. Labor Econ.* **2007**, *25*, 231–263.
60. Masi, C.M.; Hawkey, L.C.; Piotrowski, Z.H.; Pickett, K.E. Neighbourhood economic disadvantage, violent crime, group density, and pregnancy outcomes in a diverse, urban population. *Soc. Sci. Med.* **2007**, *65*, 2440–2457.
61. Farley, T.A.; Mason, K.; Rice, J.; Habel, J.D.; Scribner, R.; Cohen, D.A. The relationship between the neighbourhood environment and adverse birth outcomes. *Paediatr. Perinat. Epidemiol.* **2006**, *20*, 188–200.
62. Grady, S.C. Racial disparities in low birth weight and the contribution of residential segregation: A multilevel analysis. *Soc. Sci. Med.* **2006**, *63*, 3013–3029.

63. Messer, L.C.; Kaufman, J.S.; Dole, N.; Savitz, D.A.; Laraia, B.A. Neighbourhood crime, deprivation, and preterm birth. *Ann. Epidemiol.* **2006**, *16*, 455–462.
64. Subramanian, S.V.; Chen, J.T.; Rehkopf, D.H.; Waterman, P.D.; Krieger, N. Comparing individual- and area-based socioeconomic measures for the surveillance of health disparities: A multilevel analysis of Massachusetts births, 1989–1991. *Am. J. Epidemiol.* **2006**, *164*, 823–834.
65. Krieger, N.; Chen, J.T.; Waterman, P.D.; Rehkopf, D.H.; Subramanian, S.V. Painting a truer picture of U.S. socioeconomic and racial/ethnic health inequalities: The Public Health Disparities Geocoding Project. *Am. J. Public Health* **2005**, *95*, 312–323.
66. Reagan, P.B.; Salsberry, P.J. Race and ethnic differences in determinants of preterm birth in the USA: Broadening the social context. *Soc. Sci. Med.* **2005**, *60*, 2217–2228.
67. Buka, S.L.; Brennan, R.T.; Rich-Edwards, J.W.; Raudenbush, S.W.; Earls, F. Neighbourhood support and the birth weight of urban infants. *Am. J. Epidemiol.* **2003**, *157*, 1–8.
68. Krieger, N.; Chen, J.T.; Waterman, P.D.; Soobader, M.J.; Subramanian, S.V.; Carson, R. Choosing area-based socioeconomic measures to monitor social inequalities in low birth weight and childhood lead poisoning: The Public Health Disparities Geocoding Project (U.S.). *J. Epidemiol. Community Health* **2003**, *57*, 186–199.
69. Rich-Edwards, J.W.; Buka, S.L.; Brennan, R.T.; Earls, F. Diverging associations of maternal age with low birth weight for Black and White mothers. *Int. J. Epidemiol.* **2003**, *32*, 83–90.
70. Kaufman, J.S.; Dole, N.; Savitz, D.A.; Herring, A.H. Modeling community-level effects on preterm birth. *Ann. Epidemiol.* **2003**, *13*, 377–384.
71. Pickett, K.E.; Ahern, J.E.; Selvin, S.; Abrams, B. Neighbourhood socioeconomic status, maternal race and preterm delivery: A case-control study. *Ann. Epidemiol.* **2002**, *12*, 410–418.
72. Wegner, E.L.; Loos, G.P.; Onaka, A.T.; Crowell, D.; Li, Y.; Zheng, H. Changes in the association of low birth weight with socioeconomic status in Hawaii: 1970–1990. *Soc. Biol.* **2001**, *48*, 196–211.
73. Rauh, V.A.; Andrews, H.F.; Garfinkel, R.S. The contribution of maternal age to racial disparities in birth weight: A multilevel perspective. *Am. J. Public Health* **2001**, *91*, 1815–1824.
74. Fang, J.; Madhavan, S.; Alderman, M.H. Low birth weight: Race and maternal nativity—Impact of community income. *Pediatr.* **1999**, *103*, E5:1–E5:6.
75. Silva, A.; Whitman, S.; Margellos, H.; Ansell, D. Evaluating Chicago’s success in reaching the Healthy People 2000 goal of reducing health disparities. *Public Health Rep.* **2001**, *116*, 484–494.
76. Sundquist, J.; Sundquist, K.; Johansson, S.E.; Li, X.; Winkleby, M. Mothers, places and small for gestational age births: A cohort study. *Arch. Dis. Childhood* **2011**, *96*, 380–385.
77. Agyemang, C.; Vrijkotte, T.G.M.; Droomers, M.; van der Wal, M.F.; Bonsel, G.J.; Stronks, K. The effect of neighbourhood income and deprivation on pregnancy outcomes in Amsterdam, The Netherlands. *J. Epidemiol. Community Health* **2009**, *63*, 755–760.
78. Sellström, E.; Arnoldsson, G.; Bremberg, S.; Hjern, A. Are there differences in birth weight between neighbourhoods in a Nordic welfare state? *BMC Public Health* **2007**, *7*, 267, doi: 10.1186/1471-2458-7-267.

79. Dibben, C.; Sigala, M.; Macfarlane, A. Area deprivation, individual factors and low birth weight in England: Is there evidence of an “area effect”? *J. Epidemiol. Community Health* **2006**, *60*, 1053–1059.
80. Janghorbani, M.; Stenhouse, E.; Millward, A.; Jones, R.B. Neighbourhood deprivation and preterm birth in Plymouth, UK. *J. Matern. Fetal Neonatal. Med.* **2006**, *19*, 85–91.
81. Lasbeur, L.; Kaminski, M.; Ancel, P.-Y.; Mazaubrun, C.D.; Zeitlin, J.; Epipage Paris-Petite, C. Analysis of social inequalities in perinatal health using census data: The risk of very preterm birth in the Paris region. *Population* **2006**, *61*, 485–502.
82. Smith, G.C.; Shah, I.; White, I.R.; Pell, J.P.; Crossley, J.A.; Dobbie, R. Maternal and biochemical predictors of spontaneous preterm birth among nulliparous women: A systematic analysis in relation to the degree of prematurity. *Int. J. Epidemiol.* **2006**, *35*, 1169–1177.
83. Bundred, P.; Manning, D.; Brewster, B.; Buchan, I. Social trends in singleton births and birth weight in Wirral residents, 1990–2001. *Arch. Dis. Child. Fetal Neonatal. Ed.* **2003**, *88*, F421–F425.
84. Aveyard, P.; Cheng, K.K.; Manaseki, S.; Gardosi, J. The risk of preterm delivery in women from different ethnic groups. *BJOG* **2002**, *109*, 894–849.
85. Bonellie, S.R. Effect of maternal age, smoking and deprivation on birth weight. *Pediatr. Perinat. Epidemiol.* **2001**, *15*, 19–26.
86. Spencer, N.; Bambang, S.; Logan, S.; Gill, L. Socioeconomic status and birth weight: Comparison of an area-based measure with the Registrar General’s social class. *J. Epidemiol. Community Health* **1999**, *53*, 495–498.
87. Spencer, N.J.; Logan, S.; Gill, L. Trends and social patterning of birth weight in Sheffield, 1985–94. *Arch. Dis. Child. Fetal Neonatal. Ed.* **1999**, *81*, F138–F140.
88. Smith, L.K.; Draper, E.S.; Manktelow, B.N.; Dorling, J.S.; Field, D.J. Socioeconomic inequalities in very preterm birth rates. *Arch. Dis. Child. Fetal Neonatal. Ed.* **2007**, *92*, F11–F14.
89. Messer, L.C.; Vinikoor, L.C.; Laraia, B.A.; Kaufman, J.S.; Eyster, J.; Holzman, C.; Culhane, J.; Elo, I.; Burke, J.G.; O’Campo, P. Socioeconomic domains and associations with preterm birth. *Soc. Sci. Med.* **2008**, *67*, 1247–1257.
90. Collins, J.W., Jr.; Simon, D.M.; Jackson, T.A.; Drolet, A. Advancing maternal age and infant birth weight among urban African Americans: The effect of neighbourhood poverty. *Ethn. Dis.* **2006**, *16*, 180–186.
91. Ahern, J.; Pickett, K.E.; Selvin, S.; Abrams, B. Preterm birth among African American and White women: A multilevel analysis of socioeconomic characteristics and cigarette smoking. *J. Epidemiol. Community Health* **2003**, *57*, 606–611.
92. English, P.B.; Kharrazi, M.; Davies, S.; Scalf, R.; Waller, L.; Neutra, R. Changes in the spatial pattern of low birth weight in a southern California county: The role of individual and neighbourhood level factors. *Soc. Sci. Med.* **2003**, *56*, 2073–2088.
93. Pearl, M.; Braveman, P.; Abrams, B. The relationship of neighbourhood socioeconomic characteristics to birth weight among 5 ethnic groups in California. *Am. J. Public Health* **2001**, *91*, 1808–1814.
94. Howell, E.M.; Pettit, K.L.; Kingsley, G.T. Trends in maternal and infant health in poor urban neighbourhoods: Good news from the 1990s, but challenges remain. *Public Health Rep.* **2005**, *120*, 409–417.

95. Taylor-Robinson, D.; Agarwal, U.; Diggle, P.J.; Platt, M.J.; Yoxall, B.; Alfievic, Z. Quantifying the impact of deprivation on preterm births: A retrospective cohort study. *PLoS One* **2011**, *6*, e23163, doi: 10.1371/journal.pone.0023163.
96. Zeitlin, J.; Combier, E.; Levailant, M.; Lasbeur, L.; Pilkington, H.; Charreire, H.; Rivera, L. Neighbourhood socio-economic characteristics and the risk of preterm birth for migrant and non-migrant women: A study in a French district. *Paed. Perinatal Epidemiol.* **2011**, *25*, 347–356.
97. Hillemeier, M.M.; Weisman, C.S.; Chase, G.A.; Dyer, A.M. Individual and community predictors of preterm birth and low birth weight along the rural-urban continuum in central Pennsylvania. *J. Rural Health* **2007**, *23*, 42–48.
98. Morenoff, J.D. Neighbourhood mechanisms and the spatial dynamics of birth weight. *Am. J. Sociol.* **2003**, *108*, 976–1017.
99. Young, R.L.; Weinberg, J.; Vieira, V.; Aschengrau, A.; Webster, T.F. A multilevel non-hierarchical study of birth weight and socioeconomic status. *Int. J. Health Geographics* **2010**, *9*, 36, doi: 10.1186/1476-072X-9-36.
100. Jaffee, K.D.; Perloff, J.D. An ecological analysis of racial differences in low birth weight: Implications for maternal and child health social work. *Health Soc. Work* **2003**, *28*, 9–22.
101. Calling, S.; Li, X.; Sundquist, J.; Sundquist, K. Socioeconomic inequalities and infant mortality of 46,470 preterm infants born in Sweden between 1992 and 2006. *Paed. Perinatal. Epidemiol.* **2011**, *25*, 357–365.
102. Clausen, T.; Oyen, N.; Henriksen, T. Pregnancy complications by overweight and residential area. A prospective study of an urban Norwegian cohort. *Acta Obstet. Gynecol. Scand.* **2006**, *85*, 526–533.
103. Delpisheh, A.; Kelly, Y.; Rizwan, S.; Brabin, B.J. Socio-economic status, smoking during pregnancy and birth outcomes: An analysis of cross-sectional community studies in Liverpool (1993–2001). *J. Child Health Care* **2006**, *10*, 140–148.
104. Debbink, M.P.; Bader, M.D. Racial residential segregation and low birth weight in Michigan's metropolitan areas. *Am. J. Public Health* **2011**, *101*, 1714–1720.
105. Kramer, M.R.; Cooper, H.L.; Drews-Botsch, C.D.; Waller, L.A.; Hogue, C.R. Metropolitan isolation segregation and Black-White disparities in very preterm birth: A test of mediating pathways and variance explained. *Soc. Sci. Med.* **2010**, *71*, 2108–2116.
106. Walton, E. Residential segregation and birth weight among racial and ethnic minorities in the United States. *J. Health Soc. Behav.* **2009**, *50*, 427–442.
107. Bell, J.F.; Zimmerman, F.J.; Almgren, G.R.; Mayer, J.D.; Huebner, C.E. Birth outcomes among urban African-American women: A multilevel analysis of the role of racial residential segregation. *Soc. Sci. Med.* **2006**, *63*, 3030–3045.
108. McFarland, M.; Smith, C.A. Segregation, race, and infant well-being. *Pop. Res. Policy Rev.* **2011**, *30*, 467–493.
109. Lobmayer, P.; Wilkinson, R.G. Inequality, residential segregation by income, and mortality in US cities. *J. Epidemiol. Community Health* **2002**, *56*, 183–187.
110. Guest, A.M.; Almgren, G.; Hussey, J.M. The ecology of race and socioeconomic distress: Infant and working-age mortality in Chicago. *Demography* **1998**, *35*, 23–34.

111. Polednak, A. Trends in urban Black infant mortality by degree of residential segregation. *Am. J. Public Health* **1996**, *86*, 723–726.
112. Bird, S.T.; Bauman, K.E. The relationship between structural and health services variables and state-level infant mortality in the United States. *Am. J. Public Health* **1995**, *85*, 26–29.
113. Laveist, T.A. Segregation, poverty, and empowerment: Health consequences for African Americans. *Milbank Q.* **1993**, *71*, 41–64.
114. Polednak, A.P. Poverty, residential segregation, and Black/White mortality ratios in urban areas. *J. Health Care Poor Underserved* **1993**, *4*, 363–373.
115. Polednak, A.P. Black-White differences in infant mortality in 38 standard metropolitan statistical areas. *Am. J. Public Health* **1991**, *81*, 1480–1482.
116. LaVeist, T.A. Simulating the effects of poverty on the race disparity in post-neonatal mortality. *J. Public Health Policy* **1990**, *11*, 463–473.
117. LaVeist, T.A. Linking residential segregation to the infant mortality race disparity in U.S. cities. *Sociol. Soc. Res.* **1989**, *73*, 90–94.
118. Yankauer, A.; Allaway, N.C. The relation of indices of fetal and infant loss to residential segregation: A follow-up report. *Am. Soc. Rev.* **1958**, *23*, 573–578.
119. Yankauer, A., Jr. The relationship of fetal and infant mortality to residential segregation: An inquiry into social epidemiology. *Am. Soc. Rev.* **1950**, *15*, 644–648.
120. Vinikoor, L.C.; Kaufman, J.S.; Maclehose, R.F.; Laraia, B.A. Effects of racial density and income incongruity on pregnancy outcomes in less segregated communities. *Soc. Sci. Med.* **2008**, *66*, 255–259.
121. Pickett, K.E.; Collins, J.W.; Masi, C.M.; Wilkinson, R.G. Ethnic density effects on maternal and infant health in the Millenium Cohort Study. *Soc. Sci. Med.* **2009**, *69*, 1476–1483.
122. Hearst, M.O.; Oakes, J.M.; Johnson, P.J. The effect of racial segregation on Black infant mortality. *Am. J. Epidemiol.* **2008**, *168*, 1247–1254.
123. Nkansah-Amankra, S.; Dhawain, A.; Hussey, J.R.; Luchok, K.J. Maternal social support and neighbourhood income inequality as predictors of low birth weight and preterm birth outcome disparities: Analysis of South Carolina Pregnancy Risk Assessment and Monitoring System survey, 2000–2003. *Mat. Child Health J.* **2010**, *14*, 774–785.
124. Olson, M.E.; Diekema, D.; Elliott, B.A.; Renier, C.M. Impact of income and income inequality on infant health outcomes in the United States. *Pediatrics* **2010**, *126*, 1165–1173.
125. Sohler, N.L.; Arno, P.S. Income inequality and infant mortality in New York City. *J. Urban Health* **2003**, *80*, 650–657.
126. Ross, N.A.; Wolfson, M.C.; Dunn, J.R.; Berthelot, J.-M.; Kaplan, G.A.; Lynch, J.W. Relation between income inequality and mortality in Canada and in the United States: Cross sectional assessment using census data and vital statistics. *Br. Med. J.* **2000**, *320*, 898–902.
127. Shi, L.; Starfield, B.; Kennedy, B.; Kawachi, I. Income inequality, primary care, and health indicators. *J. Family Practice* **1999**, *48*, 275–284.
128. Kennedy, B.P.; Kawachi, I.; Prothrow-Stith, D. Income distribution and mortality: Cross sectional ecological study of the Robin Hood index in the United States. *Br. Med. J.* **1996**, *20*, 1004–1007.

129. Kaplan, G.A.; Pamuk, E.R.; Lynch, J.W.; Cohen, R.D.; Balfour, J.L. Inequality in income and mortality in the United States: Analysis of mortality and potential pathways. *Br. Med. J.* **1996**, *312*, 999–1003.
130. Materia, E.; Cacciani, L.; Bugarini, G.; Cesaroni, G.; Davoli, M.; Mirale, M.P.; Vergine, L.; Baglio, G.; Simeone, G.; Perucci, C.A. Income inequality and mortality in Italy. *Eur. J. Public Health* **2005**, *15*, 411–417.
131. Finch, B.K. Early origins of the gradient: The relationship between socioeconomic status and infant mortality in the United States. *Demography* **2003**, *40*, 675–699.
132. Deaton, A.; Lubotsky, D. Mortality, inequality and race in American cities and states. *Soc. Sci. Med.* **2003**, *56*, 1139–1153.
133. Kawachi, I.; Kennedy, B.P.; Lochner, K.; Prothrow-Stith, D. Social capital, income inequality, and mortality. *Am. J. Public Health* **1997**, *87*, 1491–1498.
134. Nabukera, S.K.; Wingate, M.S.; Owen, J.; Salihu, H.M.; Swaminathan, S.; Alexander, G.R.; Kirby, R.S. Racial disparities in perinatal outcomes and pregnancy spacing among women delaying initiation of childbearing. *Matern. Child Health J.* **2009**, *13*, 81–89.
135. Shen, T.T.; DeFranco, E.A.; Stamilio, D.M.; Chang, J.J.; Muglia, L.J. A population based study of race-specific risk for preterm premature rupture of membranes. *Am. J. Obstet. Gynecol.* **2008**, *199*, 373:e1–373:e7.
136. Ehrenthal, D.B.; Jurkovitz, C.; Hoffman, M.; Kroelinger, C.; Weintraub, W. A population study of the contribution of medical comorbidity to the risk of prematurity in Blacks. *Am. J. Obstet. Gynecol.* **2007**, *197*, 409:e1–409:e6.
137. Kistka, Z.A.; Palomar, L.; Lee, K.A.; Boslaugh, S.E.; Wangler, M.F.; Cole, F.S.; DeBaun, M.R.; Muglia, L.J. Racial disparity in the frequency of recurrence of preterm birth. *Am. J. Obstet. Gynecol.* **2007**, *196*, 131:e1–131:e6.
138. Buescher, P.A.; Mittal, M. Racial disparities in birth outcomes increase with maternal age: Recent data from North Carolina. *North Carolina Med. J.* **2006**, *67*, 16–20.
139. Dominguez, T.P.; Schetter, C.D.; Mancuso, R.; Rini, C.M.; Hobel, C. Stress in African American pregnancies: Testing the roles of various stress concepts in prediction of birth outcomes. *Ann. Behav. Med.* **2005**, *29*, 12–21.
140. Dole, N.; Savitz, D.A.; Siega-Riz, A.M.; Hertz-Picciotto, I.; McMahon, M.J.; Buekens, P. Psychosocial factors and preterm birth among African American and White women in central North Carolina. *Am. J. Public Health* **2004**, *94*, 1358–1365.
141. Rosenberg, L.; Palmer, J.R.; Wise, L.A.; Horton, N.J.; Corwin, M.J. Perceptions of racial discrimination and the risk of preterm birth. *Epidemiology* **2002**, *13*, 646–652.
142. Berg, C.J.; Wilcox, L.S.; d’Almada, P.J. The prevalence of socioeconomic and behavioural characteristics and their impact on very low birth weight in Black and White infants in Georgia. *Matern. Child Health J.* **2001**, *5*, 75–84.
143. Adams, M.M.; Elam-Evans, L.D.; Wilson, H.G.; Gilbertz, D.A. Rates of and factors associated with recurrence of preterm delivery. *J. Am. Med. Assoc.* **2000**, *283*, 1591–1596.
144. Foster, H.W.; Wu, L.; Bracken, M.B.; Semenza, K.; Thomas, J.; Thomas, J. Intergenerational effects of high socioeconomic status on low birth weight and preterm birth in African Americans. *J. Natl. Med. Assoc.* **2000**, *92*, 213–221.

145. Alexander, G.R.; Kogan, M.D.; Himes, J.H.; Mor, J.M.; Goldenberg, R. Racial differences in birth weight for gestational age and infant mortality in extremely low-risk US populations. *Paed. Perinat. Epidemiol.* **1999**, *13*, 205–217.
146. David, R.; Collins, J. Differing birth weight among infants of U.S.-born Blacks, African-born Blacks, and U.S.-born Whites. *N. Engl. J. Med.* **1997**, *337*, 1209–1214.
147. Singh, G.K.; Yu, S.M. Adverse pregnancy outcomes: Differences between US- and foreign-born women in major US racial and ethnic groups. *Am. J. Public Health.* **1996**, *86*, 837–843.
148. Schoendorf, K.C.; Hogue, C.J.; Kleinman, J.C.; Rowley, D. Mortality among infants of Black as compared with White college educated parents. *N. Engl. J. Med.* **1992**, *326*, 1522–1526.
149. Abrams, B.; Newman, V. Small-for-gestational age birth: Maternal predictors and comparison with risk factors of spontaneous delivery in the same cohort. *Am. J. Obstet. Gynecol.* **1991**, *164*, 785–790.
150. Kleinman, J.C.; Kessel, S.S. Racial differences in low birth weight: Trends and risk factors. *N. Engl. J. Med.* **1987**, *317*, 749–753.
151. Shiono, P.; Klebanoff, M. Ethnic differences in preterm and very preterm delivery. *Am. J. Public Health.* **1986**, *76*, 1317–1321.
152. Reeske, A.; Kutschmann, M.; Razum, O.; Spallek, J. Stillbirth differences according to regions of origin: An analysis of the German perinatal database, 2004–2007. *BMC Pregn. Childbirth* **2011**, *11*, 63, doi: 10.1186/1471-2393-11-63.
153. Kelly, Y.; Panico, L.; Bartley, M.; Marmot, M.; Nazroo, J.; Sacker, A. Why does birth weight vary among ethnic groups in the UL? Findings from the Millennium Cohort Study. *J. Public Health* **2008**, *31*, 131–137.
154. Essén, B.; Hanson, B.S.; Östergren, P.O.; Lindquist, P.G.; Gudmundsson, S. Increased perinatal mortality among sub-Saharan immigrants in a city-population in Sweden. *Acta Obstetr. Gyn. Scand.* **2000**, *79*, 737–743.
155. Vangen, S.; Stoltenberg, C.; Elise, R.; Sundby, J.; Stray-Pedersen, B. Perinatal complications among ethnic Somalis in Norway. *Acta Obstetr. Gyn. Scand.* **2002**, *81*, 317–322.
156. Collins, J.W., Jr.; David, R.J.; Handler, A.; Wall, S.; Andes, S. Very low birth weight in African American infants: The role of maternal exposure to interpersonal racial discrimination. *Am. J. Public Health.* **2004**, *94*, 2132–2138.
157. Mustillo, S.; Krieger, N.; Gunderson, E.P.; Sidney, S.; McCreath, H.; Kiefe, C.I. Self-reported experiences of racial discrimination and Black-White differences in preterm and low birth weight deliveries: the CARDIA Study. *Am. J. Public Health* **2004**, *94*, 2125–2131.
158. Collins, J.W., Jr.; David, R.J.; Symons, R.; Handler, A.; Wall, S.N.; Dwyer, L. Low-income African-American mothers' perception of exposure to racial discrimination and infant birth weight. *Epidemiology* **2000**, *11*, 337–339.
159. Goldenberg, R.L.; Iams, J.D.; Mercer, B.M.; Meis, P.J.; Moawad, A.H.; Copper, R.L.; Das, A.; Thom, E.; Johnson, F.; McNellis, D. The preterm prediction study: The value of new vs. standard risk factors in predicting early and all spontaneous preterm births. NICHD MFMU Network. *Am. J. Public Health.* **1998**, *88*, 233–238.
160. Dailey, D.E. Social stressors and strengths as predictors of infant birth weight in low-income African American women. *Nurs. Res.* **2009**, *58*, 340–347.

161. Korte, J.E. Psychosocial Stress and Its Relationship to Weight for Gestational Age and Gestational Age at Delivery. Ph.D. Thesis, University of North Carolina at Chapel Hill, Chapel Hill, NC, USA, May 1999.
162. Shiono, P.H.; Rauh, V.A.; Park, M.; Lederman, S.A.; Zuskas, D. Ethnic differences in birth weight: The role of lifestyle and other factors. *Am. J. Public Health*. **1997**, *87*, 787–793.
163. Murrell, N.L. Stress, self-esteem, and racism: Relationships with low birth weight and preterm delivery in African American women. *J. Natl. Black Nurses Assoc.* **1996**, *8*, 45–53.
164. Acevedo-Garcia, D.; Soobader, M.J.; Berkman, L.F. Low birth weight among U.S. Hispanic/Latino subgroups: The effect of maternal foreign-born status and education. *Soc. Sci. Med.* **2007**, *65*, 2503–2516.
165. Astone, N.M.; Misra, D.; Lynch, C. The effect of maternal socio-economic status throughout the lifespan on infant birth weight. *Pediatr. Perinat. Epidemiol.* **2007**, *21*, 310–318.
166. El Reda, D.K.; Grigorescu, V.; Posner, S.F.; Davis-Harrier, A. Lower rates of preterm birth in women of Arab ancestry: An epidemiologic paradox—Michigan, 1993–2002. *Matern. Child Health J.* **2007**, *11*, 622–627.
167. Colen, C.G.; Geronimus, A.T.; Bound, J.; James, S.A. Maternal upward socioeconomic mobility and Black-White disparities in infant birth weight. *Am. J. Public Health*. **2006**, *96*, 2032–2039.
168. Goldman, N.; Kimbro, R.T.; Turra, C.M.; Pebley, A.R. Socioeconomic gradients in health for White and Mexican-origin populations. *Am. J. Public Health*. **2006**, *96*, 2186–2193.
169. Madan, A.; Palaniappan, L.; Urizar, G.; Wang, Y.; Fortmann, S.P.; Gould, J.B. Sociocultural factors that affect pregnancy outcomes in two dissimilar immigrant groups in the U.S. *J. Pediatr.* **2006**, *148*, 341–346.
170. Messer, L.C.; Laraia, B.A.; Kaufman, J.S.; Eyster, J.; Holzman, C.; Culhane, J.; Elo, I.; Burke, J.G.; O’Campo, P. The development of a standardized neighbourhood deprivation index. *J. Urban Health* **2006**, *83*, 1041–1062.
171. Acevedo-Garcia, D.; Soobader, M.J.; Berkman, L.F. The differential effect of foreign-born status on low birth weight by race/ethnicity and education. *Pediatrics* **2005**, *115*, e20–e30.
172. Ponce, N.A.; Hoggatt, K.J.; Wilhelm, M.; Ritz, B. Preterm birth: The interaction of traffic-related air pollution with economic hardship in Los Angeles neighbourhoods. *Am. J. Epidemiol.* **2005**, *162*, 140–148.
173. Nicolaidis, C.; Ko, C.W.; Saha, S.; Koepsell, T.D. Racial discrepancies in the association between paternal vs. maternal educational level and risk of low birth weight in Washington State. *BMC Pregnancy Childbirth* **2004**, *4*, 10, doi: 10.1186/1471-2393-4-10.
174. Savitz, D.A.; Kaufman, J.S.; Dole, N.; Siega-Riz, A.M.; Thorp, J.M., Jr; Kaczor, D.T. Poverty, education, race, and pregnancy outcome. *Ethn. Dis.* **2004**, *14*, 322–329.
175. Steward, D.K.; Moser, D.K. Intrauterine growth retardation in full-term newborn infants with birth weights greater than 2,500 g. *Res. Nurs. Health* **2004**, *27*, 403–412.
176. Gould, J.B.; Madan, A.; Qin, C.; Chavez, G. Perinatal outcomes in two dissimilar immigrant populations in the U.S.: A dual epidemiologic paradox. *Pediatrics* **2003**, *111*, e676–e682.
177. Abrevaya, J. The effects of demographics and maternal behaviour on the distribution of birth outcomes. *Empirical Econ.* **2001**, *26*, 247–257.

178. Rolett, A.; Kiely, J.L. Maternal sociodemographic characteristics as risk factors for preterm birth in twins *versus* singletons. *Paediatr. Perinat. Epidemiol.* **2000**, *14*, 211–218.
179. Shmueli, A.; Cullen, M.R. Birth weight, maternal age, and education: New observations from Connecticut and Virginia. *Yale J. Biol. Med.* **1999**, *72*, 245–258.
180. Gorman, B.K. Racial and ethnic variation in low birth weight in the U.S.: Individual and contextual determinants. *Health Place* **1999**, *5*, 195–207.
181. du Prel, X.; Kramer, U.; Behrendt, H.; Ring, J.; Oppermann, H.; Schikowski, T.; Ranft, U. Preschool children's health and its association with parental education and individual living conditions in East and West Germany. *BMC Public Health* **2006**, *6*, 312, doi: 10.1186/1471-2458-6-312.
182. Gisselmann, M.D. The influence of maternal childhood and adulthood social class on the health of the infant. *Soc. Sci. Med.* **2006**, *63*, 1023–1033.
183. Reime, B.; Ratner, P.A.; Tomaselli-Reime, S.N.; Kelly, A.; Schuecking, B.A.; Wenzlaff, P. The role of mediating factors in the association between social deprivation and low birth weight in Germany. *Soc. Sci. Med.* **2006**, *62*, 1731–1744.
184. Fairley, L. Changing patterns of inequality in birth weight and its determinants: A population-based study, Scotland 1980–2000. *Paediatr. Perinat. Epidemiol.* **2005**, *19*, 342–351.
185. Thompson, J.M.; Irgens, L.M.; Rasmussen, S.; Daltveit, A.K. Secular trends in socio-economic status and the implications for preterm birth. *Paediatr. Perinat. Epidemiol.* **2006**, *20*, 182–187.
186. Spencer, N.J. Accounting for the social disparity in birth weight: Results from an intergenerational cohort. *J. Epidemiol. Community Health* **2004**, *58*, 418–419.
187. Gissler, M.; Merilainen, J.; Vuori, E.; Hemminki, E. Register based monitoring shows decreasing socioeconomic differences in Finnish perinatal health. *J. Epidemiol. Community Health* **2003**, *57*, 433–439.
188. Ronda, E.; Regidor, E. Higher birth weight and lower prevalence of low birth weight in children of agricultural workers than in those of workers in other occupations. *J. Occup. Environ. Med.* **2003**, *45*, 34–40.
189. Moser, K.; Li, L.; Power, C. Social inequalities in low birth weight in England and Wales: Trends and implications for future population health. *J. Epidemiol. Community Health* **2003**, *57*, 687–691.
190. Raum, E.; Arabin, B.; Schlaud, M.; Walter, U.; Schwartz, F.W. The impact of maternal education on intrauterine growth: A comparison of former West and East Germany. *Int. J. Epidemiol.* **2001**, *30*, 81–87.
191. Ancel, P.Y.; Saurel-Cubizolles, M.J.; Di Renzo, G.C.; Papiernik, E.; Breart, G. Very and moderate preterm births: Are the risk factors different? *Br. J. Obstet. Gynaecol.* **1999**, *106*, 1162–1170.
192. Basso, O.; Olsen, J.; Christensen, K. Study of environmental, social, and paternal factors in preterm delivery using sibs and half sibs: A population-based study in Denmark. *J. Epidemiol. Community Health* **1999**, *53*, 20–23.
193. Blumenshine, P.M.; Egerter, S.A.; Libet, M.L.; Braveman, P.A. Father's education: An Independent Marker of Risk for Preterm Birth. *Matern. Child Health J.* **2011**, *15*, 60–67.
194. Reagan, P.B.; Salsberry, P.J.; Olsen, R.J. Does the measure of economic disadvantage matter? Exploring the effect of individual and relative deprivation on intrauterine growth restriction. *Soc. Sci. Med.* **2007**, *64*, 2016–2129.

195. Finch, B.K. Socioeconomic gradients and low birth weight: Empirical and policy considerations. *Health Serv. Res.* **2003**, *38*, 1819–1841.
196. Braveman, P.; Cubbin, C.; Marchi, K.; Egerter, S.; Chavez, G. Measuring socioeconomic status/position in studies of racial/ethnic disparities: Maternal and infant health. *Public Health Rep.* **2001**, *116*, 449–463.
197. Conley, D.; Bennett, N.G. Is biology destiny? Birth weight and life chances. *Am. Sociol. Rev.* **2000**, *65*, 458–467.
198. Parker, J.D.; Schoendorf, K.C.; Kiely, J.L. Associations between measures of socioeconomic status and low birth weight, small for gestational age, and premature delivery in the United States. *Ann. Epidemiol.* **1994**, *4*, 271–278.
199. Nobile, C.G.; Raffaele, G.; Altomare, C.; Pavia, M. Influence of maternal and social factors as predictors of low birth weight in Italy. *BMC Public Health*. **2007**, *7*, 192, doi: 10.1186/1471-2458-7-192.
200. Voigt, M.; Heineck, G.; Hesse, V. The relationship between maternal characteristics, birth weight and preterm delivery: Evidence from Germany at the end of the 20th century. *Econ. Hum. Biol.* **2004**, *2*, 265–280.
201. Grimmer, I.; Buhner, C.; Dudenhausen, J.W.; Stroux, A.; Reiher, H.; Halle, H.; Obladen, M. Preconceptional factors associated with very low birth weight delivery in East and West Berlin: A case-control study. *BMC Public Health* **2002**, *2*, 10, doi: 10.1186/1471-2458-2-10.
202. Lekea-Karanika, V.; Tzoumaka-Bakoula, C.; Matsaniotis, N.S. Sociodemographic determinants of low birth weight in Greece: A population study. *Paediatr. Perinat. Epidemiol.* **1999**, *13*, 65–77.
203. Misra, D.P.; O’Campo, P.; Strobino, D. Testing a sociomedical model for preterm delivery. *Paediatr. Perinat. Epidemiol.* **2001**, *15*, 110–122.
204. Longo, D.R.; Kruse, R.L.; LeFevre, M.L.; Schramm, W.F.; Stockbauer, J.W.; Howell, V. An investigation of social and class differences in very-low birth weight outcomes: A continuing public health concern. *J. Health Care Finance* **1999**, *25*, 75–89.
205. Villalbi, J.R.; Salvador, J.; Cano-Serral, G.; Rodriguez-Sanz, M.C.; Borrell, C. Maternal smoking, social class and outcomes of pregnancy. *Paediatr. Perinat. Epidemiol.* **2007**, *21*, 441–447.
206. Dejin-Karlsson, E.; Ostergren, P.O. Country of origin, social support and the risk of small for gestational age birth. *Scand. J. Public Health*. **2004**, *32*, 442–449.
207. Skórzyńska, H.; Rudnicka-Drozak, E. Social and medical factors of risk of premature births and prematurity. *Annales Universitatis Mariae Curie-Sklodowska* **1999**, *54*, 345–350.
208. Vagero, D.; Koupilova, I.; Leon, D.A.; Lithell, U.B. Social determinants of birth weight, ponderal index and gestational age in Sweden in the 1920s and the 1980s. *Acta Paediatr.* **1999**, *88*, 445–453.
209. Lobel, M.; Cannella, L.; Graham, J.E.; DeVincent, C.; Schneider, J.; Meyer, B.A. Pregnancy-specific stress, prenatal health behaviours, and birth outcomes. *Health Psychol.* **2008**, *27*, 604–615.
210. Orr, S.T.; James, S.A.; Miller, C.A.; Barakat, B.; Daikoku, M.; Pupkin, M.; Engstrom, K.; Huggins, G. Psychosocial stressors and low birth weight in an urban population. *Am. J. Prev. Med.* **1996**, *12*, 459–466.

211. Doucette, J.T.; Bracken, M.B. Possible role of asthma in the risk of preterm labor and delivery. *Epidemiology* **1993**, *4*, 143–150.
212. Shiono, P.H.; Klebanoff, M.A.; Rhoads, G.G. Smoking and drinking during pregnancy. Their effects on preterm birth. *JAMA* **1986**, *255*, 82–84.
213. van den Berg, B.J.; Oechsli, F.W. Prematurity. In *Perinatal Epidemiology*; Bracken, M.B., Ed.; Oxford University Press: New York, NY, USA, 1984.
214. Frazier, T.M.; Davis, G.H.; Goldstein, H.; Goldberg, I.D. Cigarette smoking and prematurity: A prospective study. *Am. J. Obstet. Gynecol.* **1961**, *81*, 988–996.
215. Wisborg, K.; Henriksen, T.B.; Hedegaard, M.; Secher, N.J. Smoking during pregnancy and preterm birth. *Br. J. Obstet. Gynaecol.* **1996**, *103*, 800–805.
216. Henriksen, T.B.; Wilcox, A.J.; Hedegaard, M.; Secher, N.J. Bias in studies of preterm and postterm delivery due to ultrasound assessment of gestational age. *Epidemiology* **1995**, *6*, 533–537.
217. Ahlborg, G., Jr.; Bodin, L. Tobacco smoke exposure and pregnancy outcome among working women: A prospective study at prenatal care centers in Orebro County, Sweden. *Am. J. Epidemiol.* **1991**, *133*, 338–347.
218. Stein, A.; Campbell, E.A.; Day, A.; McPherson, K.; Cooper, P.J. Social adversity, low birth weight, and preterm delivery. *BMJ* **1987**, *295*, 291–293.
219. Obel, E.B. Pregnancy complications following legally induced abortion: an analysis of the population with special reference to prematurity. *Dan. Med. Bull.* **1979**, *26*, 192–199.
220. Russell, C.S.; Taylor, R.; Law, C.E. Smoking in pregnancy, maternal blood pressure, pregnancy outcome, baby weight and growth, and other related factors: A prospective study. *Br. J. Prev. Soc. Med.* **1968**, *22*, 119–126.
221. Siega-Riz, A.M.; Adair, L.S.; Hobel, C.J. Maternal underweight status and inadequate rate of weight gain during the third trimester of pregnancy increases the risk of preterm delivery. *J. Nutr.* **1996**, *126*, 146–153.
222. Wen, S.W.; Goldenberg, R.L.; Cutter, G.R.; Hoffman, H.J.; Cliver, S.P. Intrauterine growth retardation and preterm delivery: Prenatal risk factors in an indigent population. *Am. J. Obstet. Gynecol.* **1990**, *162*, 213–218.
223. Naeye, R.L. Factors that predispose to premature rupture of the fetal membranes. *Obstet. Gynecol.* **1982**, *60*, 93–98.
224. Rush, D.; Kass, E.H. Maternal smoking: A reassessment of the association with perinatal mortality. *Am. J. Epidemiol.* **1972**, *96*, 183–196.
225. Yerushalmy, J. Mother's cigarette smoking and survival of the infant. *Am. J. Obstet. Gynecol.* **1964**, *88*, 505–518.
226. Nordentoft, M.; Lou, H.C.; Hansen, D.; Nim, J.; Pryds, O.; Rubin, P.; Hemmingsen, R. Intrauterine growth retardation and premature delivery: The influence of maternal smoking and psychosocial factors. *Am. J. Public Health* **1996**, *86*, 347–354.
227. Peacock, J.L.; Bland, J.M.; Anderson, H.R. Preterm delivery: Effects of socioeconomic factors, psychological stress, smoking, alcohol, and caffeine. *BMJ* **1995**, *311*, 531–535.
228. Donovan, J.W. Randomised controlled trial of anti-smoking advice in pregnancy. *Br. J. Prev. Soc. Med.* **1977**, *31*, 6–12.

229. Glynn, L.M.; Dunkel-Schetter, C.; Hobel, C.J.; Sandman, C.A. Pattern of perceived stress and anxiety in pregnancy predicts preterm birth. *Health Psychol.* **2008**, *27*, 43–51.
230. Stinson, J.C.; Lee, K.A. Premature labor and birth: Influence of rank and perception of fatigue in active duty military women. *Mil. Med.* **2003**, *168*, 385–389.
231. Orr, S.T.; James, S.A.; Blackmore Prince, C. Maternal prenatal depressive symptoms and spontaneous preterm births among African-American women in Baltimore, Maryland. *Am. J. Epidemiol.* **2002**, *156*, 797–802.
232. Wadhwa, P.D.; Sandman, C.A.; Porto, M.; Dunkel-Schetter, C.; Garite, T.J. The association between prenatal stress and infant birth weight and gestational age at birth: A prospective investigation. *Am. J. Obstet. Gynecol.* **1993**, *169*, 858–865.
233. Reeb, K.G.; Graham, A.V.; Zyzanski, S.J.; Kitson, G.C. Predicting low birth weight and complicated labor in urban Black women: A biopsychosocial perspective. *Soc. Sci. Med.* **1987**, *25*, 1321–1327.
234. Wisner, K.L.; Sit, D.K.; Hanusa, B.H.; Moses-Kolko, E.L.; Bogen, D.L.; Hunker, D.F.; Perel, J.M.; Jones-Ivy, S.; Bodnar, L.M.; Singer, L.T. Major depression and antidepressant treatment: Impact on pregnancy and neonatal outcomes. *Am. J. Psychiatry* **2009**, *166*, 557–566.
235. Neggers, Y.; Goldenberg, R.; Cliver, S.; Hauth, J. The relationship between psychosocial profile, health practices, and pregnancy outcomes. *Acta. Obstet. Gynecol. Scand.* **2006**, *85*, 277–285.
236. Jesse, D.E.; Seaver, W.; Wallace, D.C. Maternal psychosocial risks predict preterm birth in a group of women from Appalachia. *Midwifery* **2003**, *19*, 191–202.
237. Zimmer-Gembeck, M.J.; Helfand, M. Low birth weight in a public prenatal care program behavioural and psychosocial risk factors and psychosocial intervention. *Soc. Sci. Med.* **1996**, *43*, 187–197.
238. Steer, R.A.; Scholl, T.O.; Hediger, M.L.; Fischer, R.L. Self-reported depression and negative pregnancy outcomes. *J. Clin. Epidemiol.* **1992**, *45*, 1093–1099.
239. Class, Q.A.; Lichtenstein, P.; Långström, N.; D’Onofrio, B.M. Timing of prenatal maternal exposure to severe life events and adverse pregnancy outcomes: A population study of 2.6 million pregnancies. *Psychosomatic Med.* **2011**, *73*, 234–241.
240. Martini, J.; Knappe, S.; Beesdo-Baum, K.; Lieb, R.; Wittchen, H.U. Anxiety disorders before birth and self-perceived distress during pregnancy: Associations with maternal depression and obstetric, neonatal and early childhood outcomes. *Early Hum. Dev.* **2010**, *86*, 305–310.
241. Khashan, A.S.; McNamee, R.; Abel, K.M.; Mortensen, P.B.; Kenny, L.C.; Pedersen, M.G.; Webb, R.T.; Baker, P.N. Rates of preterm birth following antenatal maternal exposure to severe life events: A population-based cohort study. *Hum Reprod.* **2009**, *24*, 429–437.
242. Hedegaard, M.; Henriksen, T.B.; Secher, N.J.; Hatch, M.C.; Sabroe, S. Do stressful life events affect duration of gestation and risk of preterm delivery? *Epidemiology* **1996**, *7*, 339–345.
243. Dayan, J.; Creveuil, C.; Marks, M.N.; Conroy, S.; Herlicoviez, M.; Dreyfus, M.; Tordjman, S. Prenatal depression, prenatal anxiety, and spontaneous preterm birth: A prospective cohort study among women with early and regular care. *Psychosom. Med.* **2006**, *68*, 938–946.
244. Dayan, J.; Creveuil, C.; Herlicoviez, M.; Herbel, C.; Baranger, E. Antenatal depression, a risk factor for prenatal delivery. *Presse Med.* **1999**, *28*, 1698.

245. Hedegaard, M.; Henriksen, T.B.; Sabroe, S.; Secher, N.J. Psychological distress in pregnancy and preterm delivery. *BMJ* **1993**, *307*, 234–239.
246. Kramer, M.S.; Lydon, J.; Seguin, L.; Goulet, L.; Kahn, S.R.; McNamara, H.; Genest, J.; Dassa, C.; Chen, M.F.; Sharma, S.; *et al.* Stress pathways to spontaneous preterm birth: The role of stressors, psychological distress, and stress hormones. *Am. J. Epidemiol.* **2009**, *169*, 1319–1326.
247. Strange, L.B. Sleep patterns of women at risk for the development of preterm labor. *Diss. Abstr. Int.* **2004**, *65*, 665B.
248. James, T.D. The effects of chronic stress on the duration of pregnancy. *Diss. Abstr. Int.* **2000**, *61*, 2472B.
249. Diego, M.A.; Field, T.; Hernandez-Reif, M.; Schanberg, S.; Kuhn, C.; Gonzalez-Quintero, V.H. Prenatal depression restricts fetal growth. *Early Hum. Dev.* **2009**, *85*, 65–70.
250. Gavin, A.R.; Holzman, C.; Siefert, K.; Tian, Y. Maternal depressive symptoms, depression, and psychiatric medication use in relation to risk of preterm delivery. *Womens Health Issues* **2009**, *19*, 325–334.
251. Li, D.; Liu, L.; Odouli, R. Presence of depressive symptoms during early pregnancy and the risk of preterm delivery: A prospective cohort study. *Hum. Reprod.* **2009**, *24*, 146–153.
252. Suri, R.; Altshuler, L.; Helleman, G.; Burt, V.K.; Aquino, A.; Mintz, J. Effects of antenatal depression and antidepressant treatment on gestational age at birth and risk of preterm birth. *Am. J. Psychiatry* **2007**, *164*, 1206–1213.
253. Haas, J.S.; Fuentes-Afflick, E.; Stewart, A.L.; Jackson, R.A.; Dean, M.L.; Brawarsky, P.; Escobar, G.J. Prepregnancy health status and the risk of preterm delivery. *Arch. Pediatr. Adolesc. Med.* **2005**, *159*, 58–63.
254. Dole, N.; Savitz, D.A.; Hertz-Picciotto, I.; Siega-Riz, A.M.; McMahon, M.J.; Buekens, P. Maternal stress and preterm birth. *Am. J. Epidemiol.* **2003**, *157*, 14–24.
255. Hoffman, S.; Hatch, M.C. Depressive symptomatology during pregnancy: Evidence for an association with decreased fetal growth in pregnancies of lower social class women. *Health Psychol.* **2000**, *19*, 535–543.
256. Copper, R.L.; Goldenberg, R.L.; Das, A.; Elder, N.; Swain, M.; Norman, G.; Ramsey, R.; Cotroneo, P.; Collins, B.A.; Johnson, F.; *et al.* The preterm prediction study: Maternal stress is associated with spontaneous preterm birth at less than thirty-five weeks' gestation. *Am. J. Obstet. Gynecol.* **1996**, *175*, 1286–1292.
257. Perkin, M.R.; Bland, J.M.; Peacock, J.L.; Anderson, H.R. The effect of anxiety and depression during pregnancy on obstetric complications. *Br. J. Obstet. Gynaecol.* **1993**, *100*, 629–634.
258. Krabbendam, L.; Smits, L.; de Bie, R.; Bastiaanssen, J.; Stelma, F.; van Os, J. The impact of maternal stress on pregnancy outcome in a well-educated Caucasian population. *Paediatr. Perinat. Epidemiol.* **2005**, *19*, 421–425.
259. Henriksen, T.B.; Hedegaard, M.; Secher, N.J. The relation between psychosocial job strain, and preterm delivery and low birth weight for gestational age. *Int. J. Epidemiol.* **1994**, *23*, 764–774.
260. Elsenbruch, S.; Benson, S.; Rücke, M.; Rose, M.; Dudenhausen, J.; Pincus-Knackstedt, M.K.; Klapp, B.F.; Arck, P.C. Social support during pregnancy: Effects on maternal depressive symptoms, smoking and pregnancy outcome. *Hum. Reprod.* **2007**, *22*, 869–877.

261. Berle, J.O.; Mykletun, A.; Daltveit, A.K.; Rasmussen, S.; Holsten, F.; Dahl, A.A. Neonatal outcomes in offspring of women with anxiety and depression during pregnancy: A linkage study from The Nord-Trøndelag Health Study (HUNT) and Medical Birth Registry of Norway. *Arch. Women's Ment. Health* **2005**, *8*, 181–189.
262. Andersson, L.; Sundström-Poromaa, I.; Wulff, M.; Åström, M.; Bixo, M. Neonatal outcome following maternal antenatal depression and anxiety: A population based study. *Am. J. Epidemiol.* **2004**, *159*, 872–881.
263. Rossin, M. The effects of maternity leave on children's birth and infant health outcomes in the United States. *J. Health Econ.* **2011**, *30*, 221–239.
264. Papiernik, E.; Goffinet, F. Prevention of preterm births, the French experience. *Clin. Obstetr. Gyn.* **2004**, *47*, 755–767.
265. Lu, M.C.; Kotelchuck, M.; Hogan, V.; Jones, L.; Wright, K.; Halfon, N. Closing the Black-White gap in birth outcomes: A lifecourse approach. *Ethn. Dis.* **2010**, *20*, 62–76.
266. Kim, D.; Baum, C.F.; Ganz, M.; Subramanian, S.V.; Kawachi, I. The contextual effects of social capital on health: A cross-national instrumental variable analysis. *Soc. Sci. Med.* **2011**, *73*, 1689–1697.
267. Kramer, M.R.; Hogue, C.R. What causes racial disparities in very preterm birth? A biosocial perspective. *Epidemiol. Rev.* **2009**, *31*, 84–98.
268. Goldenberg, R.L.; Culhane, J.F.; Iams, J.D.; Romero, R. Epidemiology and causes of preterm birth. *Lancet* **2008**, *371*, 75–84.
269. Lu, M.C.; Halfon, N. Racial and ethnic disparities in birth outcomes: A life-course perspective. *Mat. Child Health J.* **2003**, *7*, 13–30.
270. Collins, J.W.; David, R.J. Racial disparity in low birth weight and infant mortality. *Clin. Perinatol.* **2009**, *36*, 63–73.
271. Giurgescu, C.; McFarlin, B.L.; Lomax, J.; Craddock, C.; Albrecht, A. Racial discrimination and the Black-White gap in adverse birth outcomes: A review. *J. Midwifery Womens Health* **2011**, *56*, 362–370.
272. Gissler, M.; Alexander, S.; Macfarlane, A.; Small, R.; Stray-Pedersen, B.; Zeitlin, J.; Zimbeck, M.; Gagnon, A. Stillbirths and infant deaths among migrants in industrialized countries. *Acta Obstetr. Gyn.* **2009**, *88*, 134–148.
273. Arntzen, A.; Nybo Anderson, A.M. Social determinants for infant mortality in the Nordic countries, 1980–2001. *Scand. J. Public Health* **2004**, *32*, 381–389.
274. Arntzen, A.; Mortensen, L.; Schnor, O.; Cnattingius, S.; Gissler, M.; Nybo Anderson, A. Neonatal and post-neonatal mortality by maternal education—A population-based study of trends in the Nordic countries, 1981–2000. *Eur. J. Public Health* **2007**, *18*, 245–251.
275. Forssas, E.; Gissler, M.; Sihvonen, M.; Hemminki, E. Maternal predictors of perinatal mortality: The role of birth weight. *Int. J. Epidemiol.* **1999**, *28*, 475–478.
276. Barger, M.K. Maternal nutrition and perinatal outcomes. *J. Midwifery Womens Health* **2010**, *55*, 502–511.
277. Catov, J.M.; Bodnar, L.M.; Ness, R.B.; Markovic, N.; Roberts, J.M. Association of periconceptional multivitamin use and risk of preterm or small-for-gestational-age births. *Amer. J. Epidemiol.* **2007**, *166*, 296–303.

278. Dunlop, A.L.; Kramer, M.R.; Hogue, C.J.; Menon, R.; Ramakrishnan, U. Racial disparities in preterm birth: An overview of the potential role of nutrient deficiencies. *Acta Obstetr. Gyn.* **2011**, *90*, 1332–1341.
279. Tennant, P.W.G.; Rankin, J.; Bell, R. Maternal body mass index and the risk of fetal and infant death: A cohort study from the North of England. *Hum. Reprod.* **2011**, *26*, 1501–1511.
280. Knight, M.; Kurinczuk, J.J.; Spark, P.; Brocklehurst, P.; UK Obstetric Surveillance System. Extreme obesity in pregnancy in the United Kingdom. *Obstetr. Gyn.* **2010**, *115*, 989–997.
281. Maconochie, N.; Doyle, P.; Prior, S.; Simmons, R. Risk factors for first trimester miscarriage—Results from a UK-population-based case-control study. *Br. J. Obstetr. Gyn.* **2006**, *114*, 170–186.
282. Grote, N.K.; Bridge, J.A.; Gavin, A.R.; Melville, J.L.; Iyengar, S.; Katon, W.J. A meta-analysis of depression during pregnancy and the risk of preterm birth, low birth weight, and intrauterine growth restriction. *Arch. General Psychiatr.* **2010**, *67*, 1012–1024.
283. Giscombé, C.L.; Lobel, M. Explaining disproportionately high rates of adverse birth outcomes among African Americans: The impact of stress, racism, and related factors in pregnancy. *Psychol. Bull.* **2005**, *131*, 662–683.
284. Alder, J.; Fink, N.; Bitzer, J.; Hösl, I.; Holzgreve, W. Depression and anxiety during pregnancy: A risk factor for obstetric, fetal and neonatal outcome? A critical review of the literature. *J. Matern. Fetal Neonatal. Med.* **2007**, *20*, 189–209.
285. Preston, S.H. The changing relation between mortality and level of economic development. *Popul. Stud.* **1975**, *29*, 231–248.
286. Ward, A.C. The role of causal criteria in causal inferences: Bradford Hill’s “aspects of association”. *Epidemiol. Perspect. Innov.* **2009**, *6*, 2, doi: 10.1186/1742-5573-6-2.
287. Luo, Z.; Gardiner, J.C.; Bradley, C.J. Applying propensity score methods in medical research: Pitfalls and prospects. *Med. Care Res. Rev.* **2010**, *67*, 528–554.
288. Suarez, D.; Borràs, R.; Basagaña, X. Differences between marginal structural models and conventional models in their exposure effect estimates: A systematic review. *Epidemiology* **2011**, *22*, 586–588.
289. Warnecke, R.B.; Oh, A.; Breen, N.; Gehlert, S.; Paskett, E.; Tucker, K.L.; Lurie, N.; Rebbeck, T.; Goodwin, J.; Flack, J.; *et al.* Approaching health disparities from a population perspective: The National Institutes of Health Centers for Population Health and Health Disparities. *Am. J. Public Health* **2008**, *98*, 1608–1615.
290. Committee on the Review and Assessment of the NIH’s Strategic Research Plan and Budget to Reduce and Ultimately Eliminate Health Disparities. *Examining the Health Disparities Research Plan of the National Institutes of Health: Unfinished Business*; National Academy Press: Washington, DC, USA, 2006.
291. Rose, G. Sick individuals and sick populations. *Int. J. Epidemiol.* **1985**, *14*, 32–38.
292. Bailer, J.C. The promise and problems of meta-analysis. *N. Engl. J. Med.* **1997**, *337*, 559–561.
293. Adelaide Statement on Health in All Policies: Moving towards a Shared Governance for Health and Well-Being. In *Health in All Policies International Meeting, Adelaide, 13–15 April 2010*; World Health Organization: Geneva, Switzerland, 2010.

294. Nair, M.; Webster, P.; Ariana, P. Impact of non-health policies on infant mortality through the social determinants pathway. *Bull. WHO* **2011**, *89*, 778, doi: 10.2471/BLT.11.093799.

© 2013 by the authors; licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/3.0/>).