



REVIEW ARTICLE

## Maternal education level and low birth weight: a meta-analysis<sup>☆</sup>

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### Abstract

**Objective:** To assess the association between maternal education level and birth weight, considering the circumstances in which the excess use of technology in healthcare, as well as the scarcity of these resources, may result in similar outcomes.

**Methods:** A meta-analysis of cohort and cross-sectional studies was performed; the studies were selected by systematic review in the MEDLINE database using the following Key\*\*words socioeconomic factors, infant, low birth weight, cohort studies, cross-sectional studies. The summary measures of effect were obtained by random effect model, and its results were obtained through forest plot graphs. The publication bias was assessed by Egger's test, and the Newcastle-Ottawa scale was used to assess study quality.

**Results:** The initial search found 729 articles. Of these, 594 were excluded after reading the title and abstract; 21, after consensus meetings among the three reviewers; 102, after reading the full text; and three for not having the proper outcome. Of the nine final articles, 88.8% had quality  $\geq$  six stars (Newcastle-Ottawa Scale), showing good quality studies. The heterogeneity of the articles was considered moderate. High maternal education showed a 33% protective effect against low birth weight, whereas medium degree of education showed no significant protection when compared to low maternal education.

**Conclusions:** The hypothesis of similarity between the extreme degrees of social distribution, translated by maternal education level in relation to the proportion of low birth weight, was not confirmed.

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**PALAVRAS-CHAVE**

Escolaridade;  
Recém-nascido de  
baixo peso;  
Meta-análise

**Grau de escolaridade materna e baixo peso ao nascer: uma meta-análise****Resumo**

**Objetivo:** Analisar a associação entre grau de escolaridade materna e peso de nascimento, considerando-se a hipótese de que a utilização em excesso das tecnologias na área da saúde, assim como a escassez de recursos, pode produzir desfechos similares.

**Métodos:** Realizou-se uma meta-análise com estudos transversais e de coorte, selecionados por revisão sistemática na base de dados bibliográficos MEDLINE com os descritores: *socioeconomic factors; infant, low birth weight; cohort studies; cross-sectional studies*. As medidas de sumário de efeito foram obtidas pelo modelo de efeito aleatório, e os seus resultados apresentados por intermédio dos gráficos *Forest Plot*. O viés de publicação foi analisado pelo Teste de Egger, e a avaliação da qualidade dos estudos utilizou a Escala de Newcastle-Ottawa.

**Resultados:** A busca inicial encontrou 729 artigos. Destes, foram excluídos 594, após a leitura do título e do resumo; 21, após reuniões de consenso entre os três revisores; 102, após leitura do texto completo; e três, por não possuírem o desfecho adequado. Dos nove artigos finais, 88,8% apresentavam uma qualidade igual ou superior a seis estrelas (Escala de Newcastle-Ottawa), configurando boa qualidade aos estudos. A heterogeneidade dos artigos foi considerada moderada. A escolaridade materna elevada mostrou um efeito protetor de 33% sobre o baixo peso ao nascer, enquanto que o grau médio não apresentou proteção significativa, quando comparados à escolaridade materna baixa.

**Conclusões:** A hipótese de similaridade entre os graus extremos da distribuição social, traduzidas pelo nível de escolaridade materna, em relação à proporção de baixo peso ao nascer, não foi confirmada.

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**Introduction**

There are several determinants of low birth weight (LBW) – weight at birth < 2,500 grams –, and one of the most relevant is maternal social status, which has a close and direct association with maternal education level. Even in developed countries, mothers in unfavorable socioeconomic status and with low education level present greater vulnerability to having LBW children.<sup>1</sup>

Conversely, the use of new health technologies in the preconception, prenatal, and perinatal periods has led to an increase in the proportion of LBW, especially in the more affluent social strata, which have greater access to such procedures.<sup>2</sup> Additionally, late pregnancies also add to this outcome. Recent observational studies have shown an increase in LBW in more privileged social groups and in regions with higher economic growth.<sup>3,4</sup>

An intense demographic and epidemiological transition is currently observed in Brazil, characterized by a decrease in infant mortality rates, especially due to the decrease in deaths from infectious diseases and the marked reduction in fertility rates. Considering this scenario, a hypothesis has been developed that the two extremes of the social classifications would show a high proportion of LBW: in one, due to scarcity of resources; in the other, due to an abundance of technologies. This hypothesis has been termed “similarity in inequality”.<sup>5,6</sup>

In this context, this study aimed to investigate the similarity hypothesis in the proportion of LBW between the two extremes of the social strata, assessed by maternal education level, through a meta-analysis. With the study results, the intention is to obtain subsidies for the development of public policy strategies aimed at equalization of resources employed in the maternal-child health area.

**Methods****Article search and selection strategy**

Article search was performed until November of 2011, using the MEDLINE database. The search strategy previously defined the combination of key words in health sciences to be used as “socioeconomic factors”[MeSH] AND “infant, low birth weight”[MeSH] AND (“cohort studies”[MeSH] OR “cross-sectional studies”[MeSH]). For inclusion in the study, the articles were required to be cross-sectional or cohort studies; published in English, Portuguese or Spanish; have LBW (< 2,500 g) as outcome; and the variable maternal level of schooling was required to have been divided into three strata (low, medium, and high). Two independent reviewers found and selected the articles. The doubts were discussed with a third reviewer for final resolution on the inclusion or exclusion of the article.

**Article quality assessment (Newcastle-Ottawa scale)**

The internal quality of included studies was assessed using the Newcastle-Ottawa scale,<sup>7</sup> which evaluates the design and quality of nonrandomized studies, and also facilitates incorporation of assessments of quality in the interpretation of the meta-analysis results, albeit not used as a criterion for inclusion or exclusion of articles. The evaluation of each article is given a score consisting in a number of stars from three perspectives: a) selection (maximum: four stars), b) comparability (maximum: two stars), and c) results (maximum: three stars).

Thus, when processing the article quality analysis, a maximum of nine stars can be obtained for high-quality studies. Lower-quality studies receive fewer stars.

### Statistical analysis

Of the articles included, the data were obtained in absolute numbers, using the low maternal education stratum as reference. Analyses were performed comparing, individually, the higher and medium level of education with the lower level. To obtain summary measures of effect, analyses were conducted in accordance with the random effect model.<sup>8</sup> Heterogeneity among the studies was analyzed by statistical I<sup>2</sup> test.<sup>8-10</sup>

Analyses were performed using STATA software, release 10.0; the metan command was used for the estimates of combined effect. Publication bias was analyzed by funnel plot, using the metafunnel command through Egger’s test. To adjust for possible publication bias, the trim-and-fill method was used. It checks the asymmetry of the funnel plot, inputs a supposed number of lost studies, and recalculates the summary of effect on results, which can be used to

analyze the extent of publication bias that may affect the estimate.<sup>11</sup>

### Results

According to the search strategy used, 729 articles were initially identified. After reading the title and abstract, 114 of these articles were selected, which were read in their entirety (15.6% of the previously selected articles). Of this total, 97 articles were excluded due to the following reasons: lack of the variables proposed in the study (23); designs that were different from those established for the study (7); result presentation using a format that did not follow the three proposed social stratifications - high, medium, and low (35); and those with insufficient or inadequate information (40). Of the remaining 17 articles, eight other studies were excluded by the third reviewer due to disagreements between the first two reviewers. The remaining nine articles considered stratification in three levels of schooling. The complete flowchart of final article selection for the meta-analysis is shown in Fig. 1.

ARTICLES	
Total	Excluded
n = 729 <i>(Initially identified*)</i>	
	594 <i>(Through analysis of title and summary)</i>
n = 135	
	14 <i>(Consensus between the two reviewers)</i>
n = 121	
	7 <i>(Decided by the third reviewer due to discordance between the two reviewers)</i>
n = 114	
	97 <i>(After reading the entire text)</i>
n = 17	
	8 <i>(Decided by the third reviewer due to discordance between the two reviewers)</i>
n = 9	

\* According to the search strategy used.

Figure 1 Flow chart of article selection for the meta-analysis.

**Table 1** List of articles included in the final meta-analysis and low-birth weight rates in different social strata.

Articles	Study type	Country	Newcastle-Ottawa scale	Total	Proportion of LBW (%)		
					Level of schooling		
					Low	Medium	High
Akoijam et al. <sup>12</sup>	Cross-sectional	India	5 stars	4,662	17.3	11.9	10.1
Dubois & Girard <sup>13</sup>	Cohort	Canada	9 stars	2,048	4.8	2.4	3.5
Gorsky & Colby <sup>14</sup>	Cohort	USA	8 stars	51,126	7.7	5.1	4.1
Ko et al. <sup>15</sup>	Cohort	Taiwan	6 stars	624	0.0	5.8	5.0
Miller & Jekel <sup>a 16</sup>	Cross-sectional	USA	6 stars	711	2.5	2.7	0.9
Miller & Jekel <sup>a 16</sup>	Cross-sectional	USA	6 stars	311	2.8	4.4	3.5
Niedhammer et al. <sup>17</sup>	Cohort	Ireland	7 stars	676	1.4	3.7	3.0
Starfield et al. <sup>a 18</sup>	Cohort	USA	7 stars	1,368	11.9	11.4	7.7
Starfield et al. <sup>a 18</sup>	Cohort	USA	7 stars	2,349	6.2	6.1	2.8
Vadhaninia et al. <sup>19</sup>	Cross-sectional	Iran	6 stars	3,726	4.7	5.1	1.2
Wergeland et al. <sup>20</sup>	Cross-sectional	Norway	7 stars	3,299	2.4	3.5	4.1
Total/Mean				70,900	7.2	6.9	5.0

LBW, low birth weight.

<sup>a</sup> The studies by Miller & Jekel<sup>16</sup> and by Starfield et al.<sup>18</sup> show data with analysis stratified by ethnicity, assessing LBW between white and non-white mothers; these are represented twice as if they were individual studies.

The final list of the nine articles can be found in Table 1,<sup>12-20</sup> which shows that the proportion of LBW does not have a similar distribution pattern between the different levels of maternal education, and is not more prevalent at the extremes of the classification. Lower rates of LBW were observed in the groups with low education level in three studies, which were conducted in developed countries (United States, Ireland, and Norway), whereas only one study (performed in Canada) observed a lower rate of LBW associated with a medium education level.

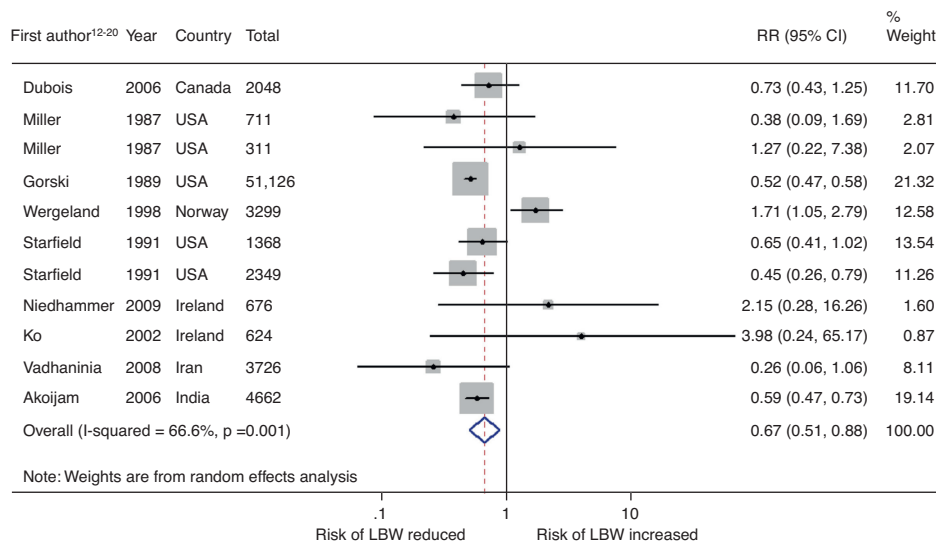
When assessing the quality of articles according to the Newcastle-Ottawa Scale, only one had five stars. Among the remaining studies, the following classifications were obtained: three studies obtained six stars, three obtained seven stars, one obtained eight stars, and another one obtained nine stars (Table 1).

To analyze the influence of maternal education level on low-birth weight risk, two meta-analyses were performed. The first compared high level with low level maternal education and the other compared medium level with low level. 70,900 mother-child pairs were included in the analysis.

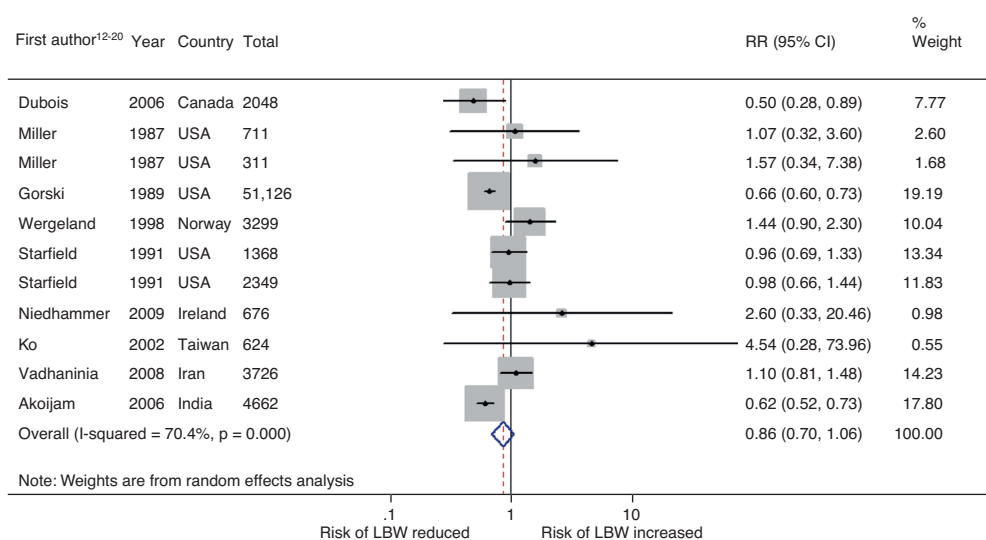
### Meta-analysis of high maternal education effect on LBW

Fig. 2 shows that the summary of effect of the meta-analysis results was 0.67 (95% CI: 0.51-0.88), demonstrating the protective effect for LBW caused by high maternal education when compared to low.

The heterogeneity (*I*<sup>2</sup>) of 66.6% is considered moderate. Egger's test, used to assess the publication bias of the



**Figure 2** Forest plot of the effect of high maternal education level, when compared to low education level, on low birth weight. LBW, low birth weight; RR, relative risk; CI, confidence interval.



**Figure 3** Forest plot of the effect of high-school maternal education level, when compared to low education level, on low birth weight. LBW, low birth weight; RR, relative risk; CI, confidence interval.

studies included in this meta-analysis, showed absence of bias ( $p=0.148$ ).

### Meta-analysis of the effect of medium maternal education on LBW

Fig. 3 shows the results of the summary effect of the meta-analysis, which was 0.86 (95% CI: 0.70-1.06), demonstrating no significant protective effect for LBW in the group with medium maternal education, when compared to low. The heterogeneity ( $I^2$ ) of 70.4% was considered moderate

Egger's test, unlike the previous analysis, showed the presence of bias ( $p=0.027$ ). To recalculate the size of the effect in each insert until the funnel plot becomes symmetrical, the trim-and-fill method was used, which estimated a loss of five studies. Subsequent to this correction, the summary of effect was 0.71 (95% CI: 0.56-0.88).

### Discussion

The hypothesis of similarity in inequality was tested to investigate whether LBW(similarity) would be related to the extreme levels of maternal education - high and low (inequality). This theory was initially developed by Silveira et al., in 2005, in an attempt to explain the obesity epidemic in Latin America, with similar prevalence between the extremes of the social strata.<sup>6</sup> Similarly, the hypothesis was confirmed when it was observed that regional differences in Brazil regarding the proportion of LBW appear to be more related to the availability of perinatal care than the social status, a phenomenon which the authors called the "epidemiological paradox of LBW in Brazil".<sup>21</sup>

However, the meta-analysis did not support the previously proposed hypothesis. A protective effect of 33% for the risk of LBW was identified among women with higher education, when compared with the low maternal

education category. In contrast, when assessing the risk of LBW in mothers with medium level of schooling, when compared those with low education level, there were no significant results.

The choice of maternal education as the variable to represent social inclusion was established due to its significance in the contemporary socioeconomic context, translated by its current association with material goods, as well as nonmaterial goods, such as access to information and behavior in the presence of health challenges, and social status. However, the impact of this variable on a particular outcome may be related to the way it was stratified during the processing of analyses (continuous, quartile, or percentile, for instance), therefore modifying the results.

Maternal education has been considered a suitable variable to measure inequality in health care and to assess pregnancy outcomes.<sup>22-24</sup> Particularly in relation to the latter, the results are contradictory. Some researchers have observed an increase in the proportion of LBW in groups with higher socioeconomic status.<sup>3</sup>

The influence of maternal education on birth weight can also be observed in different continents. In Iran, the prevalence of LBW in infants born to women with no education was 16.9%, decreasing to 5.4% ( $p<0.008$ ) with increasing level of schooling.<sup>25</sup> In Asia, a study conducted in Bangladesh showed that the incidence of LBW was 32.7% in children born to women who had no formal education, and 1.8% in those with high school or higher education level.<sup>26</sup>

Other studies have found similar results: women who did not complete high school had a 9% higher probability of having a LBW child than women with high school or higher education level.<sup>27</sup> It was also observed that mothers with less than eight years of formal education are 1.5 times more likely to have LBW infants.<sup>28</sup>

Independently, mean birth weight also showed to be associated with maternal education. Mothers who had finished university or had a higher level of education had children



whose weight was up to 82 g [95% CI: 4-160] higher than those who had completed only high school or had a lower level of education.<sup>29</sup> Another study, using the same research object, verified that children born to mothers with low education significantly have a birth weight approximately 123 g lower than those born to mothers with higher education.<sup>30</sup> In contrast, a study in the United States did not observe differences between levels of maternal education on LBW, according to ethnic classification: the education level of non-white American women has no influence on LBW.<sup>31</sup>

The rationale for the association between maternal education level and LBW appears to be related to the low socioeconomic level of mothers, who possibly have a lower weight gain during pregnancy, late start of prenatal care, and fewer consultations than recommended. Regarding prenatal care, the number of consultations was also associated with maternal education. Mothers with higher levels of education were twice as likely to have more than six consultations during the prenatal period, and the first one occurred earlier.<sup>28</sup>

The association between the importance of maternal education on maternal-child health can be understood by the fact that women with higher levels of education are more prone to take care of themselves, have greater knowledge of the care that must be performed, have a higher socioeconomic status and better judgment when making decisions regarding their health and care. Several studies conducted in different countries have shown that education is the strongest socioeconomic predictor of health status, when considered alone, and the most important determinant of birth weight in a population.<sup>32,33</sup>

Many of the selected articles had, in addition to the maternal education variable, social class, asset ownership, social segregation, income, housing location, and neighborhood, and little information on individual maternal characteristics that was the objective of this study. There was no objective correlation between all the different variables and the LBW outcome. Individually, they showed an association with birth weight at different proportions with their specific limitations.

Particularly concerning maternal education, a significant number of articles classified this variable in more than three strata, making its inclusion impossible. Moreover, several studies did not report how the classification was performed in high, medium, or low stratum, as each country has different parameters based on their social reality, and thus it could influence the protective findings related to high education level.

Another important aspect concerns the samples used, as many studies had small and medium-sized samples. The more robust studies, characterized by a larger sample size, can influence the final results during analysis processing.

Finally, it should be emphasized that the authors' hypothesis, which led to the performance of this meta-analysis, was formulated in recent years. However, the selection of included articles covers an almost three-decade period, which certainly contributes to the results.

## Conflicts of interests

The authors declare no conflicts of interest.

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