RESEARCH ARTICLE

REVISED An ecological study on the association between early childhood caries and intimate partner violence in 20 low- and middle-income countries: 2007-2017 [version 2; peer review: 1 not approved]

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Abstract

Background: Women are the worst affected by intimate partner violence (IPV), and this impacts negatively on the health of the children they care for. This study aimed to determine the relationship between IPV and the prevalence of early childhood caries (ECC) in 3-5-year-olds.

Methods: This was an ecological study using IPV (physical, sexual, emotional) data extracted from the Demographic Health Survey of 20 low- and middle-income countries and ECC data for 3-5-year-olds of the same countries for the period 2007-2017. Linear regression analysis was used to assess the relationship between the percentage of 3-5-year-olds with ECC (outcome variable) and IPV indicators (physical, sexual, emotional). The model was adjusted for the country's gross national income and the percentage of women with secondary or higher education. Partial eta squared (η^2), regression coefficients, confidence intervals and p-values were calculated.

Results: Data on ECC in 3-5-year-olds and IPV were available for six low-income-countries, 10 lower-middle-income-countries and four

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upper-middle-income-countries. The most prevalent form of IPV was physical violence (10.09%). The Democratic Republic of Congo had the highest prevalence of physical violence (45.8%), sexual violence (25.4%), and ECC (80.0%). The strongest association was between the prevalence of ECC and emotional violence ($\eta^2=0.01$), followed by physical violence ($\eta^2=0.005$), and sexual violence ($\eta^2=0.003$). For every 1% higher prevalence of emotional violence, there was 0.28% higher prevalence of ECC, and for every 1% higher percentage of physical violence, there was 0.21% higher prevalence of ECC. On the contrary, for every 1% higher prevalence of sexual violence, there was 0.35% lower prevalence of ECC prevalence.

Conclusions: The association between IPV and the prevalence of ECC in 3-5-year-olds is minor, with the strongest direct association effect being with emotional violence; and there was an inverse association between sexual violence and the prevalence of ECC. These findings need to be studied further.

Keywords

Physical violence; Sexual violence; Emotional violence; Early childhood caries; Global; Gross National Income

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REVISED Amendments from Version 1

The authors have improved on the introduction section by including details on several other negative outcomes on children's health in addition to malnutrition; and also discussing other pathways through which maternal experience of IPV can affect their children's health. In addition, in response to the comments by the peer reviewer, we have listed the 20 countries. Please see the third paragraph in the methodology section. Also, we provided more information regarding the DHS and the El tantawi study is which were the source of data for the ecological study. The number of included and excluded studies were mentioned. Finally we revised the discussion section to highlight the non-significant relationship between IPV and ECC, and the implications of the findings.

Any further responses from the reviewers can be found at the end of the article

Introduction

Intimate partner physical, emotional and sexual violence (IPV) is a recognized threat to the health and rights of women globally^{1,2}. Global estimates in 2010 indicated that about 30% of women have a history of IPV with this being highest in central (65.6%) and western (41.8%) sub-Saharan Africa and South Asia (41.7%)³. IPV is defined as the abuse that takes place between a couple who are either married or living together and may or may not have a child⁴. IPV not only has an impact on maternal health and welfare⁵, It also affects the nutritional status of children of mothers affected by IPV: these children are more likely to be stunted⁶⁻¹². In addition, children who are exposed to IPV have increased risk of behavioural, emotional, psychological and social problems including mood and anxiety disorders, post-traumatic stress disorder, substance abuse and school-related problems¹³. Abused women are also more likely to physically abuse their children¹⁴⁻¹⁶. Children of mothers who experience IPV are also less likely to be immunized; have higher rates of diarrhoeal disease; and/or are at greater risk of dying before the age of five^{17,18}.

The negative impact on the mental health of women affected by IPV¹⁹ results in poor nutritional care of children²⁰⁻²⁵ causing an increased risk for stunting^{6-10,12}, and poor or delayed medical care access by affected children^{12,23-25}. In addition, women who experience IPV may resort to substance use as a way to cope with the emotional, physical and mental stress²⁶. Substance use may also be a way for affected persons to maintain and/or establish intimate relations with others²⁷. Substance use disorder is a risk factors for child abuse and poor management of the oral health of the child. It may affect a parent's ability to function as a caregiver and provide basic health care needs of the child²⁸.

Though several studies have established the negative association between maternal mental health and increased risk for ECC²⁹⁻³², there is little known about the association between IPV and ECC. Lorber *et al.*³³ studied children's exposure to domestic violence and the risk for ECC and found no significant relationship between them though a positive trend was

observed. However, in households where women were aggressive towards men, the risk for ECC was higher due to high exposure to cariogenic diets³⁴.

The social cognitive theory may explain the relationship between IPV and ECC. The theory recognizes that an individual's behavior, cognition, and environment reciprocally and dynamically influence one another³⁵. Key social environmental and personal factors play roles in determining an individual's engagement in health-promoting and disease-preventing behaviors³⁶. Self-efficacy is a central cognitive construct in the social cognitive theory that may predict and explain health behaviors and outcomes³⁷⁻³⁹. Thus, a person's belief or confidence in their ability to perform certain actions influences the decisions to perform these actions⁴⁰, including tooth brushing⁴¹, which is a significant risk factor for poor oral hygiene and ECC⁴². IPV undermines the self-efficacy of affected individuals^{43,44} who are mostly women⁴⁵ serving as caretakers for children⁴⁶. IPV can therefore compromise the ability of women to care for children who are entirely dependent on them for daily oral hygiene and access to professional oral health care services.

The aim of this study was to determine the relationship between the country-level prevalence of IPV and the prevalence of ECC in children aged 3-5-year-olds in countries where data on IPV and ECC are available. We conducted a country-specific analysis given the evidence suggesting differences in the relationship between IPV and ECC⁴⁷.

Methods

Study design and data sources

This ecological study was based on IPV data extracted from the domestic violence module of the Demographic Health Survey (DHS), a nationally representative household survey that collects information on population-based indicators of health and nutrition in low- and middle-income countries (LMICs). The module includes questions on types and experiences of violence (physical, sexual and emotional) mostly perpetrated by the current or most recent husband/ partner⁴⁸.

The present study also used data on ECC collected by El Tantawi *et al.*⁴⁹. The data on the prevalence of ECC between 2007 and 2017 was extracted from the WHO and other Country Oral Health Profile databases as well as from published journals and government reports after conducting a search applying no language filter. Data on ECC was generated for 113 countries using this methodology.

The Data for both IPV and ECC between 2007 and 2017 were available in only 20 LMICs (Cambodia, Columbia, Democratic Republic of Congo, Egypt, Gambia, India, Kenya, Kyrgyzstan, Myanmar, Namibia, Nepal, Nigeria, Pakistan, Peru, Philippines, Senegal, South Africa, Tanzania, Uganda and Ukraine).

Early childhood caries

ECC is identified in children < 72 months of age with one or more decayed (cavitated and non-cavitated), missing teeth due to decay or filled primary tooth surfaces⁵⁰. For each country,

databases were searched for data on ECC prevalence: (1) MEDLINE, (2) Web of Science (3) Scopus and (4) Google Scholar (1st 100 search results) using a country's name combined with search terms. This was complemented by searching master and doctoral degrees theses about ECC, articles published in local journals and government reports. No language filter was applied.

Studies were included if they (1) were conducted on humans in epidemiologic, non-laboratory setting, (2) assessed ECC using the definition of the American Academy of Pediatric Dentistry or data was available to allow its estimation and (3) included healthy children. Excluded studies were (1) duplicates such as theses and resulting publications, (2) publications from which needed information could not be extracted (article with no full text or information not mentioned) and (3) studies published before 2007.

We extracted data from studies reporting prevalence figures from nationally representative samples if they were available. Otherwise, we used the retrieved data to calculate ECC prevalence for a country by dividing the total number of children affected by ECC in the study/s by the total number of children examined and multiplying by 100.

The search strategy for Pubmed was: “Dental Caries”[Mesh] OR caries OR dental decay; Filter by age “infant: 1–23 months” and “preschool child”; Filter by date: from January 1st 2007 to December 31st 2017; Combine with “Country x” [Mesh] using “AND” The search term was as follows in case of Egypt for example: ((“Dental Caries”[MeSH Terms] OR (“caries”[All Fields] OR “Dental Caries”[MeSH Terms] OR (“dental”[All Fields] AND “caries”[All Fields]) OR “Dental Caries”[All Fields] OR “caries”[All Fields]) OR (“Dental Caries”[MeSH Terms] OR (“dental”[All Fields] AND “caries”[All Fields]) OR “Dental Caries”[All Fields] OR (“dental”[All Fields] AND “decay”[All Fields]) OR “dental decay”[All Fields])) AND “Egypt”[MeSH Terms]) AND ((2007:2017[pdat]) AND (infant[Filter] OR preschool child [Filter])).

No language filter was applied. The retrieved data were used to calculate the ECC prevalence for each country by dividing the number of children affected by ECC by the number of children examined and multiplying by 100. In the present study, we used the prevalence of ECC for 3–5-year-old children. Further details were reported in our previous paper⁴⁹.

Intimate partner violence

We investigated the history of physical violence (the intentional use of physical force with the potential to cause injury or harm), sexual violence (any experience of unwanted or forced sexual activity and sexual coercion) and emotional violence (psychological abuse including humiliation, insults and intimidation)⁵¹. Self-reported lifetime exposure to IPV was separated into three categories: (i) physical violence only; (ii) sexual violence only; and (iii) emotional violence only. Details on the source of the IPV is available in [Table 1](#).

Confounders

Income level was reported to be associated with ECC⁴⁹ and IPV³. We adjusted for country income level based on the 2015 gross national income (GNI) per capita calculated using the World Bank Atlas method⁵² since it was the latest available for the study period. In addition, we also obtained information about the percentage of women between 15 and 49 years of age who completed secondary or higher education per country from the DHS data⁵³.

Statistical analysis

The datasets (ECC and IPV indicators) were matched by country. Analysis was restricted to only women selected and successfully interviewed in the DHS domestic module and those who were formerly or currently in union or living with a man at the time of survey. Statistics, including means and standard deviations (SD), were calculated for IPV indicators, ECC, GNI and percentage of women completing secondary or higher education. Multiple linear regression analysis was used to assess the relationship between the percentage of 3-5-year-old children with ECC (outcome variable) and the three IPV indicators adjusted for GNI and percentage of women with secondary or higher education. Regression coefficients, 95% confidence intervals (CIs), p values and partial eta squared (η_p^2) as the measure of effect size were calculated using SPSS version 22.0 (IBM Corp., Armonk, N.Y., USA). Significance level was set at 5%.

Results

A total of 190 publications on ECC from 88 countries (45.6% of the UN member states) were available⁵⁴. Of these, data on ECC in 3-5-year-olds and IPV were available for 20 LMICs. These 20 countries included six low-income countries (30%), 10 lower-middle-income countries (50%) and four upper-middle-income countries (20%). In view of the small number of countries with available data, analysis was conducted for all 20 countries collectively rather than categorizing by income level. In total 68,031 children <36 months old and 154,452 children 36–71 months old were included in the study.

[Table 2](#) lists the GNI, percentage of women with secondary or higher education, the percentage of 3-5-year-old children with ECC, and the proportion of women in the country who reported (i) physical violence only; (ii) sexual violence only; and (iii) emotional violence only. The prevalence (SD) of ECC in 3-5-year-olds in these 20 countries was 62.20% (18.66) and the mean (SD) GNI was 6219.47 (4083.99) US\$ whereas the mean (SD) percentage of women with secondary or higher education was 57.15% (23.47). The most reported form of IPV was physical violence (25.46%, 10.09), followed by emotional violence (22.19%, 9.90), and lastly sexual violence (7.87%, 6.18).

The Democratic Republic of Congo (DRC), a war-torn country, had the highest prevalence of physical violence (45.8%). ECC prevalence in this country was also high (80%).

Table 1. Country Demographic Health Survey (DHS) and URL.

COUNTRY	DHS YEAR OF SURVEY	DATA URL
Cambodia	2014	https://dhsprogram.com/customcf/legacy/data/download_dataset.cfm?Filename=KHIR73DT.ZIP&Tp=1&Ctry_Code=KH&surv_id=464&dmode=normal
Colombia	2015	https://dhsprogram.com/customcf/legacy/data/download_dataset.cfm?Filename=COIR72DT.ZIP&Tp=1&Ctry_Code=CO&surv_id=476&dmode=normal
Congo, DRC	2013/14	https://dhsprogram.com/customcf/legacy/data/download_dataset.cfm?Filename=CDIR61DT.ZIP&Tp=1&Ctry_Code=CD&surv_id=421&dmode=normal
Egypt	2014	https://dhsprogram.com/customcf/legacy/data/download_dataset.cfm?Filename=EGIR61DT.ZIP&Tp=1&Ctry_Code=EG&surv_id=397&dmode=normal
Gambia	2013	https://dhsprogram.com/customcf/legacy/data/download_dataset.cfm?Filename=GMIR61DT.ZIP&Tp=1&Ctry_Code=GM&surv_id=425&dmode=normal
India	2015/16	https://dhsprogram.com/customcf/legacy/data/download_dataset.cfm?Filename=IAIR74DT.ZIP&Tp=1&Ctry_Code=IA&surv_id=355&dmode=cf
Kenya	2014	https://dhsprogram.com/customcf/legacy/data/download_dataset.cfm?Filename=KEIR72DT.ZIP&Tp=1&Ctry_Code=KE&surv_id=451&dmode=normal
Kyrgyzstan	2012	https://dhsprogram.com/customcf/legacy/data/download_dataset.cfm?Filename=KYIR61DT.ZIP&Tp=1&Ctry_Code=KY&surv_id=383&dmode=normal
Myanmar	2015/16	https://dhsprogram.com/customcf/legacy/data/download_dataset.cfm?Filename=MMIR71DT.ZIP&Tp=1&Ctry_Code=MM&surv_id=454&dmode=normal
Namibia	2013	https://dhsprogram.com/customcf/legacy/data/download_dataset.cfm?Filename=NMIR61DT.ZIP&Tp=1&Ctry_Code=NM&surv_id=363&dmode=normal
Nepal	2016	https://dhsprogram.com/customcf/legacy/data/download_dataset.cfm?Filename=NPIR7HDT.ZIP&Tp=1&Ctry_Code=NP&surv_id=472&dmode=normal
Nigeria	2013	https://dhsprogram.com/customcf/legacy/data/download_dataset.cfm?Filename=NGIR6ADT.ZIP&Tp=1&Ctry_Code=NG&surv_id=438&dmode=normal
Pakistan	2017/18	https://dhsprogram.com/customcf/legacy/data/download_dataset.cfm?Filename=PKIR71DT.ZIP&Tp=1&Ctry_Code=PK&surv_id=523&dmode=normal
Peru	2012	https://dhsprogram.com/customcf/legacy/data/download_dataset.cfm?Filename=PEIR6IDT.ZIP&Tp=1&Ctry_Code=PE&surv_id=434&dmode=normal
Philippines	2017	https://dhsprogram.com/customcf/legacy/data/download_dataset.cfm?Filename=PHIR71DT.ZIP&Tp=1&Ctry_Code=PH&surv_id=510&dmode=normal
Senegal	2017	https://dhsprogram.com/customcf/legacy/data/download_dataset.cfm?Filename=SNIR7ZDT.ZIP&Tp=1&Ctry_Code=SN&surv_id=534&dmode=normal
South Africa	2016	https://dhsprogram.com/customcf/legacy/data/download_dataset.cfm?Filename=ZAIR71DT.ZIP&Tp=1&Ctry_Code=ZA&surv_id=390&dmode=normal
Tanzania	2015/16	https://dhsprogram.com/customcf/legacy/data/download_dataset.cfm?Filename=TZIR7BDT.ZIP&Tp=1&Ctry_Code=TZ&surv_id=485&dmode=normal
Uganda	2016	https://dhsprogram.com/customcf/legacy/data/download_dataset.cfm?Filename=UGIR7BDT.ZIP&Tp=1&Ctry_Code=UG&surv_id=504&dmode=normal
Ukraine	2007	https://dhsprogram.com/customcf/legacy/data/download_dataset.cfm?Filename=UAIR51DT.ZIP&Tp=1&Ctry_Code=UA&surv_id=280&dmode=normal

Demographic Health Survey data are publicly available at: <https://dhsprogram.com/>

Sexual violence was highest in DRC, followed by Uganda (25.4%). The highest prevalence of emotional violence (41.7%) was in Uganda while the prevalence of ECC in Uganda was 41%.

Table 3 highlights the association between the percentage of 3-5-year-old children with ECC and the percentage of women with various types of IPV in the 20 LMICs after adjusting for GNI and the percentage of women with secondary and

Table 2. Distribution of early childhood caries (ECC) and indicators of interpersonal violence in the 20 countries included in the study. SD=standard deviation.

ID	Country	Gross national income in US dollars	Percentage of women with secondary or higher education	ECC prevalence in children aged 3-5-year-old %	Number of survey participants n	Country level prevalence of physical violence n (%)	Country level prevalence of sexual violence n (%)	Country level prevalence of emotional violence n (%)
1	Cambodia	3300	40.1	78.8	3,499	536 (15.3%)	164 (4.7%)	790 (22.6%)
2	Colombia	13550	82.7	75.3	24,862	8,384 (33.7%)	1,985 (8.0%)	---
3	Congo, DRC	720	47.7	80.0	5,691	2,606 (45.8%)	1,448 (25.4%)	2,073 (36.4%)
4	Egypt	10710	65.7	61.6	6,693	1,590 (23.8%)	267 (4.0%)	1,238 (18.5%)
5	Gambia	-	39.8	86.0	3,542	784 (22.1%)	103 (2.9%)	592 (16.7%)
6	India	6030	60.1	52.1	66,013	18,680 (28.3%)	4,372 (6.6%)	8,372 (12.7%)
7	Kenya	3070	46.2	64.2	4,519	1,609 (35.6%)	529 (11.7%)	1,373 (30.4%)
8	Kyrgyzstan	3310	99.5	69.8	4,832	1,283 (26.6%)	201 (4.2%)	592 (12.3%)
9	Myanmar	4930	46.3	50.0	3,425	575 (16.8%)	131 (3.8%)	544 (15.9%)
10	Namibia	10380	75.8	68.7	1,449	359 (24.8%)	106 (7.3%)	367 (25.3%)
11	Nepal	2500	50	61.5	3,826	842 (22.0%)	297 (7.8%)	485 (12.7%)
12	Nigeria	5810	50.6	14.9	22,305	3,385 (15.2%)	1,190 (5.3%)	4,477 (20.1%)
13	Pakistan	5320	34.3	60.0	4,085	1,004 (24.6%)	184 (4.5%)	1,243 (30.4%)
14	Peru	12060	75.2	76.0	13,483	5,063 (37.6%)	1,235 (9.2%)	4,187 (31.1%)
15	Philippines	8940	86.3	93.0	13,215	1,486 (11.2%)	591 (4.5%)	2,903 (22.0%)
16	Senegal	2380	32.3	73.0	2,660	546 (20.5%)	167 (6.3%)	357 (13.4%)
17	South Africa	12870	88.9	44.0	2,354	356 (15.1%)	90 (3.8%)	451 (19.2%)
18	Tanzania	2630	22.9	37.3	15,194	5,512 (36.3%)	1,882 (12.4%)	4,904 (32.3%)
19	Uganda	1820	36.1	41.0	7,536	3,138 (41.6%)	1,710 (22.7%)	3,141 (41.7%)
20	Ukraine	7840	99.9	56.7	2,453	304 (12.4%)	59 (2.4%)	510 (20.8%)
	Mean (SD)	6219.47 (4083.99)	57.15 (23.47)	62.20 (18.66)	10,581 (14,6667)	25.46 (10.09%)	7.87 (6.18%)	22.19 (9.90%)

Table 3. Association between the percentage of 3-5-year-old children with early childhood caries (ECC) and the percentage of women with various types of interpersonal violence (IPV) in 20 low- and middle-income countries (LMICs).

Factors	Regression coefficient (95% CI)	P value	Partial eta squared (η^2)
Prevalence of physical violence	0.21 (-1.74, 2.17)	0.82	0.005
Prevalence of sexual violence	-0.35 (-4.33, 3.62)	0.85	0.003
Prevalence of emotional violence	0.28 (-1.27, 1.83)	0.70	0.01

Adjusted for country gross national income (GNI) and percentage of women with secondary or higher education, CI: confidence interval

higher education. The associations between ECC and each of the three categories of IPV were non-statistically significant. The strongest association was between ECC prevalence and exposure to emotional violence ($\eta^2 = 0.01$), followed by exposure to physical violence ($\eta^2 = 0.005$), and exposure to sexual violence ($\eta^2 = 0.003$). Multiple linear regression analysis revealed that for every 1% higher percentage of women reporting exposure to physical violence, there was a 0.21% non-statistically significantly higher prevalence of ECC. For every 1% higher prevalence of sexual violence, countries had 0.35% non-statistically significantly lower ECC prevalence while for every 1% higher prevalence of emotional violence, countries had non-statistically significant 0.28% higher ECC.

Discussion

This is the first study attempting to assess the association between IPV and ECC using national data available from multiple countries around the world. This data suggests that in countries with a higher proportion of women facing physical and emotional IPV, the prevalence of ECC is also higher. However, the prevalence of ECC was lower in countries with a higher proportion of women facing sexual IPV. The relationships between the forms of IPV and ECC examined in this study were not statistically significant likely due to the relatively few numbers of countries with available information from the DHS. Also, the effect sizes observed were small though this is not unexpected given the multifactorial nature of ECC, and that IPV may be partly explained by other social determinants of health such as income and education (for which we controlled for in our analysis). The study finding, however, highlights an area for future research as there are indications that the global incidence of IPV has been on the increase⁵⁵; and the association between both IPV and ECC seems to represent co-existing issues rather a causal relationship. Factors such as culture, lifestyle and socio-economic status may be etiological or predisposing factors for ECC and IPV. Although we controlled for income and education, other related underlying factors that are not measured may be able to explain some of the observed variance among countries in the prevalence of both health problems (IPV and ECC).

The study provides new information to strengthen existing evidence on how social context is associated with disease risks. Globally, the prevalence of ECC is high – it is the 10th most prevalent childhood illness⁵⁶. Most of the efforts to address this problem have largely been limited to interventions aiming at altering biological and behavioral risk factors. Little attention has been paid to addressing the social determinants of health, significantly impact the behavioral and biological risks.

The study results suggest that the children 3-5-years-old resident in LMICs may be at increased risk for ECC when the care-giver is exposed to IPV though the effect size may be small. The stronger link between emotional violence and ECC – stronger than physical and sexual violence – may be related to post-traumatic stress disorder⁵⁷, suicidal ideation and low self-esteem⁵⁸ that results from the emotional violence. Emotional abuse often occurs prior to or concurrently with physical or sexual abuse and increases the trauma of physical

and sexual abuse⁵⁹. The risk for mental health consequences of emotional violence is higher than it is for physical and sexual violence⁵⁸. Children of mothers with mental health disorders are more likely to have ECC than children of mothers without these mental health disorders⁶⁰.

The non-significant associations between ECC and the different types of IPV and the small effect size observed may imply that the role of IPV as a structural determinant of the risk for ECC may be small for the children at this age. However, with our understanding that when children 3-5-years-old are exposed to IPV as an adverse childhood event, the risk of caries in adolescence and adulthood is significantly higher⁶¹. What this study has done is to indicate that there are signals of risk for caries when pre-schoolers are exposed to IPV. Existing studies and reviews of the IPV and oral health literature reveal that the link between IPV and ECC is quite plausible⁶². Integrating early childhood promotion and ECC prevention messages into programs that take place in women's shelters may be the first step to reduce the immediate possible risk of ECC and possible future risk for caries by offering practical methods to women to care for their children's oral health. This proposed management strategy also reiterates the importance of integrated maternal and child health care as a cost-effective strategy to manage diseases using the common risk approach⁶³. There is currently very little evidence on approaches that promote the integration of maternal and child general health-care with their – and especially the child's – oral health. As evidence emerges, it becomes needful to develop programs addressing maternal IPV and ECC in pre-school children as part of a general health screening process, especially in countries where the prevalence of IPV is high.

The inverse though non-significant relationship between sexual violence and the prevalence of ECC is difficult to explain. Studies suggest that some mothers who had experienced sexual abuse demonstrate parental reflective functioning, an essential capacity for providing sensitive care for children under routine parenting circumstances. This is also associated with the caregiver developing resilience^{64,65}. This evidence of increased child protection by mothers who have a history of sexual violence may also be reflected in the improved oral healthcare the children receive. There is however, research that demonstrated negative psychosocial impact of sexual violence with negative implications for the oral health of children⁶⁶ while another found no association between women's experience of violence and ECC⁶⁷. This finding needs to be studied further.

One of the strengths of the present study is the use of population-level data derived from the DHS, thus ensuring data quality⁶⁸. We used the data from 20 LMICs to provide insight into a phenomenon that if further explored, may shape policy and practice around ECC management⁶⁹. Our study, however, is limited by the low number of included countries thereby challenging the generalizability of findings. The low sample size was addressed by using partial eta squared, a measure of effect size, to compare the association of ECC with various forms of IPV and to decide on the importance of each variable, rather than using the p values to determine the significance of the

associations. Ensuring the availability of IPV data in other countries with different income levels may help develop a better understanding of the nature of the association between ECC and IPV.

Another limitation is that IPV data is based on self-reporting with the possibility of under-reporting due to social desirability bias⁷⁰. However, this is the standard method used to obtain information on IPV⁷¹. We also only extracted data on IPV and women though there is evidence suggestive that both males and females may be victims of IPV^{72,73}; and IPV affecting men may be associated with the risk of ECC²⁶. Also, this is a cross-sectional study. We are unable to determine a causal relationship between IPV and ECC and the direction of the relationship between the two variables though it seems less likely that ECC will cause IPV. In addition, the study is ecological with potential for ecological fallacy resulting from linking different independent data sets^{74,75}. The 20 countries included in this study were not randomly selected to represent the 135 LMICs⁷⁶. Rather they were a sample of LMICs with complete data for the variables included in this study. This limits the generalizability of the study findings to all LMICs. However, the report can be generalized to countries with similar epidemiological profiles to those represented in this study. Like all ecological studies, our study suggests the plausibility of an association between ECC and IPV although the effect size in the present case is small. Future studies are needed to look into possible associations at the individual level and assess the presence of potential mediating factors.

Conclusions

Despite these limitations, the study provides new insight into the possible association between ECC and IPV: physical,

sexual and emotional violence were associated with ECC prevalence though the associations were not significant, and the effect size of the associations were small. Women's exposure to emotional violence had stronger associations with the prevalence of ECC than physical and sexual violence.

Data availability

Underlying data

The IPV data used in this study are available from the Demographic and Health Survey (DHS) website. Access to the dataset requires registration and is granted only for legitimate research purposes. A guide for how to apply for dataset access is available at: <https://dhsprogram.com/data/Access-Instructions.cfm>. Please find the urls to the specific datasets in Table 1.

Extended data

Figshare: supplementary files for ECC and IPV manuscript. <https://doi.org/10.6084/m9.figshare.15000324.v1>⁵⁴.

This project contains the following extended data:

- supplementary file_IPV.doc (List of studies reporting early childhood caries prevalence)
- IPV_ECC.do (Analysis code)

Data are available under the terms of the [Creative Commons Attribution 4.0 International license](#) (CC-BY 4.0).

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An earlier version of this article can be found on Research Square (doi: [10.21203/rs.2.21025/v1](https://doi.org/10.21203/rs.2.21025/v1)).

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Shirin Ziaei

International Maternal and Child Health Unit (IMCH), Department of Women's and Children's Health, University Hospital, Uppsala University, Uppsala, Sweden

Thank you so much for the new version of the paper. Several of the comments have been answered. The paper is well written and clear. However, I still think that the interpretation of the results and regression analysis is misleading and the fact that the p values are very large indicates that the findings might be by chance. So, although the authors mentioned that the findings are "insignificant" still the whole result section, discussion, and also abstract are written in a form that points to the existence of association rather than non-existence. I understand that the sample size is small but with the current sample size and p values, it is not possible to draw such conclusions. Further, the Cis were not adjusted for the cluster sampling design which is also a major issue to consider.

Some minor details:

- Please change the term "relationship" to "association" throughout the manuscript. The study is cross-sectional, and causality cannot be established.
- It is helpful if the authors can mention what are the criteria of ECC from the American Academy of pediatric dentistry.
- I still have a problem with including children below 72 months old. That means the included children were under 6 yrs (full 6 years) not five and what about the criteria of age above 3 years? If the authors only restricted the search to the children under 72 months that means that children younger than 3yrs are also included. Also in the result section, it has been mentioned 68031 children were below 36 months. That is in contradiction with the method section and aim that mentioned children 3-5 years are studied.
- Please clarify the variables for the experience of IPV, the authors mentioned that they have 3 variables for IPV: "physical violence only" "sexual violence only" and "emotional violence only" does that mean that if the women experienced both physical and sexual violence for example they are not included? Violence is hardly a single act and usually, the women

experience multiple forms of violence. Perhaps the authors meant the experience of “any physical violence” etc. rather than “physical violence only”

- It is great that the authors used the weight for their statistical analysis but that is not enough when it comes to the p value and CI. They need to adjust for cluster sampling design by using the strata and cluster variables in the complex sample analysis. The current analysis is actually prone to type one error and the current p values after adjustment for the sampling design might be even bigger.

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Intimate partner violence_Maternal and child health_epidemiology

I confirm that I have read this submission and believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

Author Response 04 Jan 2022

Morenike Oluwatoyin Folayan, Obafemi Awolowo University, Ile-Ife, Nigeria

However, I still think that the interpretation of the results and regression analysis is misleading and the fact that the p values are very large indicates that the findings might be by chance. So, although the authors mentioned that the findings are “insignificant” still the whole result section, discussion, and also abstract are written in a form that points to the existence of association rather than non-existence. I understand that the sample size is small but with the current sample size and p values, it is not possible to draw such conclusions. Further, the CIs were not adjusted for the cluster sampling design which is also a major issue to consider.

- Response: We understand and acknowledge the Reviewer’s concern. Our study is ecological as indicated at the beginning of Methods. This means the units of observation and analysis are countries not persons. Because of this, our sample size is 20. This is very much under-powered to show significance. Statistical significance, however, is a function of sample size. Please check the following table. We replicated our data (n=20) several times using the same values so that the sample would reach a much greater number (n= 1440) and re-ran the same analysis. In the re-ran analysis with a greater sample size of 1440, the regression coefficients (B) and partial eta squared are exactly the same as that of our sample of 20 but the confidence intervals changed and the p values are all significant.

Prevalence of physical violence

B = 0.21; p value = 0.01; 95% CI: 0.04-0.38; Partial Eta Squared = 0.005

Prevalence of sexual violence

B = - 0.35; p value = 0.045; 95% CI: -0.70 - -0.008; Partial Eta Squared = 0.003

Prevalence of emotional violence

B = - 0.28; p value = <0.001; 95% CI: 0.15 - 0.42; Partial Eta Squared = 0.013

Our study used an ecological design where the countries were the units of observation. If the same datasets are used and the analysis is re-run at person level, the sample size would be 154,452 instead of 20 and the significance would be even greater.

Because of this, we include the effect size (partial eta squared) and considered it safe to mention the presence of associations rather than their absence. We made sure that we clarified all over the paper that the association was not significant and included the data so that our results can be replicated. We contend that there are always associations and the analysis can show whether they are significant or not (based on sample size among other things) and can also show their strength (for which we calculated the partial eta squared).

We feel our reporting and discussions of the associations and effect size were very appropriate for this form of data analysis. We have however gone ahead to revise the manuscript to focus on the non-significant association observed

It is great that the authors used the weight for their statistical analysis but that is not enough when it comes to the p value and CI. They need to adjust for cluster sampling design by using the strata and cluster variables in the complex sample analysis. The current analysis is actually prone to type one error and the current p values after adjustment for the sampling design might be even bigger.

- Response: Because we used ecological design, we calculated means for all values at country level. If the same datasets are used so that the person is the unit of analysis, persons would be clustered in countries and multilevel analysis would be needed to account for the clustering. Please check our response above clarifying that in our design where the unit of analysis is the country not the person, the values used are means of country values not persons and therefore there is no clustering and no multilevel analysis is needed.

Some minor details: Please change the term “relationship” to “association” throughout the manuscript. The study is cross-sectional, and causality cannot be established.

- Response: All the terms “relationship” changed to “association”

○ **It is helpful if the authors can mention what are the criteria of ECC from the American Academy of pediatric dentistry.**

- Response: Reference 50 defines Early childhood caries. The definitions indicate that the criteria for ECC is caries in children below 72 months old. ECC is an age based definition for caries. There are no other criterion for its definition. Other criteria are related to the determination of a diagnosis of caries.

○ **I still have a problem with including children below 72 months old. That means the included children were under 6 yrs (full 6 years) not five and what about the criteria of age above 3 years? If the authors only restricted the search to the children under 72 months that means that children younger than 3yrs are also included. Also in the result section, it has been mentioned 68031 children were below 36 months. That is in contradiction with the method section and aim that mentioned children 3-5 years are**

studied.

- **Response:** We have edited this to 36 – 71 months. Also, the data of children below 36 months was not included in the analysis. This was an error and we have edited this. Thanks for picking this up.

○ **Please clarify the variables for the experience of IPV, the authors mentioned that they have 3 variables for IPV: “physical violence only” “sexual violence only” and “emotional violence only” does that mean that if the women experienced both physical and sexual violence for example they are not included? Violence is hardly a single act and usually, the women experience multiple forms of violence. Perhaps the authors meant the experience of “any physical violence” etc. rather than “physical violence only”**

- **Response:** The DHS data used series of items/questions to capture the form of violence experienced - physical, sexual, emotional. Women who answered positive to a particular item/question are categorized to have experienced the form of violence. While it is possible to generate a variable for women who experienced multiple forms of violence, this study however presents only an experience of each form of violence. We have therefore revised the variable in line with the suggestion and we have included this as a study limitation.

Competing Interests: No competing interests were disclosed.

Version 1

Reviewer Report 01 November 2021

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Shirin Ziaei

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The paper discussed a very important issue and has a very interesting and important research question. However, I am concerned that the interpretation of the results is misleading, and the authors have gone a bit too far in trying to interpret the non-significant findings. The results as I can see are that there is no association between maternal experience of IPV and ECC. Which, as the authors mentioned, might be because of a small sample size. However, based on the p values and effects size the interpretation cannot go beyond. Please find some detailed comments below:

Introduction:

- I believe the author can develop on the association between maternal experience of IPV and child health. While stunting is definitely one of the measured outcomes, there are several negative outcomes on children's health which can be mentioned. Further, the pathways through which maternal experience of IPV can affect their children's health can be discussed a bit more. The authors have a very strong approach by using social cognitive theory. As much as self-efficacy is an important and very well-known reason, there are other possible explanations linking maternal exposure to violence and their children's health including dental health.
- "Countries where data is available" is quite a vague description. I recommend that authors talk about the number of the countries, region and list of them.

Methods.

- More information regarding DHS and El tantawi study is required.
- The number of included and excluded studies is needed in the methods.

Statistical analysis:

- I am not an expert in ecological studies but I know in DHS data we need to adjust for clustering design of the study. I wonder if the authors have considered the clustered design of DHS data in their analysis.

Result:

- I did not understand when the authors mentioned 68031 children under 36 months were included. Also, why children under 71 months? That is beyond 5 years. In the method section, the sample was children 3-5 years old.
- I do not think that the authors can come up with such an outcome interpretation that for every 1% increase in exposure to certain violence how much the prevalence of ECC increases as the p values are far from significant and i.e. the reported outcome is not associated to the exposure. Even if there is a trend there.

Discussion:

- I think the whole discussion is written in a sense that "there is an association between exposure to IPV and ECC" which is definitely not correct. Since there was no association found in the analysis, I encourage the authors to rewrite the discussion around that. In this format I think the discussion is misleading as it focuses on the reasoning why maternal experience of IPV is associated with ECC. Which is an explanation of non-significant findings.

Is the work clearly and accurately presented and does it cite the current literature?

Yes

Is the study design appropriate and is the work technically sound?

Partly

Are sufficient details of methods and analysis provided to allow replication by others?

Partly

If applicable, is the statistical analysis and its interpretation appropriate?

I cannot comment. A qualified statistician is required.

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

No

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Intimate partner violence_Maternal and child health_epidemiology

I confirm that I have read this submission and believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

Author Response 08 Nov 2021

Morenike Oluwatoyin Folayan, Obafemi Awolowo University, Ile-Ife, Nigeria

The paper discussed a very important issue and has a very interesting and important research question. However, I am concerned that the interpretation of the results is misleading, and the authors have gone a bit too far in trying to interpret the non-significant findings. The results as I can see are that there is no association between maternal experience of IPV and ECC. Which, as the authors mentioned, might be because of a small sample size. However, based on the p values and effects size the interpretation cannot go beyond. Please find some detailed comments below:

Response: Thanks for the positive feedback. We have addressed the comments. Your comments have helped to improve the quality of the manuscript. We hope the reviewers finds the revision has addressed the concerns raised

Introduction:

- I believe the author can develop on the association between maternal experience of IPV and child health. While stunting is definitely one of the measured outcomes, there are several negative outcomes on children's health which can be mentioned. Further, the pathways through which maternal experience of IPV can affect their children's health can be discussed a bit more. The authors have a very strong approach by using social cognitive theory. As much as self-efficacy is an important and very well-known reason, there are other possible explanations linking maternal exposure to violence and their children's health including dental health.

Response: We have improved on the introduction as suggested. Please see paragraph 1 and 2 of the introduction

- "Countries where data is available" is quite a vague description. I recommend that authors talk about the number of the countries, region and list of them.

Response: We have listed the 20 countries. Please see the third paragraph in the methodology section.

- Methods. More information regarding DHS and El tantawi study is required. The number of included and excluded studies is needed in the methods

Response: We have provided more details on the El tantawi study. Please see the paragraph 1 and 2 of the methodology section.

Statistical analysis: I am not an expert in ecological studies but I know in DHS data we need to adjust for clustering design of the study. I wonder if the authors have considered the clustered design of DHS data in their analysis.

Response: We agree with the Reviewer's comment. We used the weights in d005 of the DHS datasets for the values in table 2.

Result: I did not understand when the authors mentioned 68031 children under 36 months were included. Also, why children under 71 months? That is beyond 5 years. In the method section, the sample was children 3-5 years old.

Response: 71 months is 5 years.

- I do not think that the authors can come up with such an outcome interpretation that for every 1% increase in exposure to certain violence how much the prevalence of ECC increases as the p values are far from significant and i.e. the reported outcome is not associated to the exposure. Even if there is a trend there.
- **Response:** In agreement with the Reviewer's comment and to clarify our meaning and avoid misleading readers, we modified the results to reflect that the association was not significant. We based our interpretation on statistical convention (<https://www.wiley.com/WileyCDA/Section/id-831952.html> AND <https://home.csulb.edu/~msaintg/ppa696/696stsig.htm>) that tests of significance have p values that show whether associations are significant or not. Therefore, associations can be significant or non-significant. Also, significance is related to sample size and for the same variables and associations, increasing the sample size may change a non-significant association into a significant association. We thus based our interpretation of the analysis on the direction and magnitude of the association and now explicitly indicated that it was non-significant.

Discussion: I think the whole discussion is written in a sense that "there is an association between exposure to IPV and ECC" which is definitely not correct. Since there was no association found in the analysis, I encourage the authors to rewrite the discussion around that. In this format I think the discussion is misleading as it focuses on the reasoning why maternal experience of IPV is associated with ECC. Which is an explanation of non-significant findings.

Response: Thanks for highlighting this limitation with the discussion. We have revised the discussion to highlight the non-significant relationship between IPV and ECC, and the implications of the findings. We hope the reviewer will find the revision a lot more representative of the study findings and suitable

Competing Interests: The authors have no competing interest