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Abstract:

Aims: To report a systematic review of the literature exploring how education, income and occupation influence the uptake of cervical screening and HPV vaccination among eligible women in developed countries, including the United Kingdom, United States, Spain, Germany and Norway.

Background: Cervical cancer remains a highly prevalent disease despite it being largely preventable through cervical screening and HPV vaccination. Incidence and mortality of cervical cancer are unequally distributed among socioeconomic groups, warranting research into how individual socioeconomic factors contribute to this unbalanced uptake of prevention strategies.

Design: Systematic review and narrative synthesis.

Methods: The PRISMA guidelines (Moher et al., 2009) guided the selection of papers. MEDLINE, CINHAL, PsychINFO, Science Citation Index, and HMIC were searched. Ten articles were suitable. Key findings were then extracted and a narrative synthesis was completed, using suitable guidance and the AXIS tool.

Results: Obtaining high school or college education is associated with uptake of both cervical screening and HPV vaccination. Total household income and income in respect of the countries' poverty line was measured less frequently than education, but associated with

screening and vaccination in some studies. Occupation was infrequently measured in comparison to education and income, limiting conclusions of its association to uptake.

Conclusion: Education and income have an association with uptake of cervical screening and HPV vaccination among women. However, evidence is insufficient to affirm a relationship between occupation and uptake of screening and vaccination. Further research would be advised to strengthen these findings.

Relevance to clinical practice: Interventions to promote cervical cancer prevention strategies should be targeted at women and girls with lower education levels and lower income. However, differences are displayed in the relationships between the individual socioeconomic factors and uptake of preventative strategies between countries and populations and so they should be considered separately. Nurses play a considerable role in people's perceptions and experiences of cervical screening and HPV vaccination. The review findings offer new insight that can inform future policy and nursing practice on targeting interventions to promote uptake among women who are underusing cervical cancer prevention programmes.

Key words: 'cervical screening'; 'HPV vaccination'; 'socioeconomic'; 'education'; 'income'; ''occupation' 'inequalities'; 'cervical cancer prevention' 'cervical cancer';

Impact Statement: What does this paper contribute to the wider global clinical community?:

- Education and income are linked to eligible women's uptake of cervical screening and HPV vaccination. Occupation shows limited research into its association and of no significance in this review.
- Policy makers should address levels of income when considering changes to cervical screening and HPV vaccination programmes, due to the multiple factors contributing to this inequality as highlighted in this review.
- Nurses should aim interventions to promote uptake to women and girls of lower education levels and whom are in the lower income groups, in order to reduce inequalities seen in utilisation of cervical cancer prevention strategies.

'systematic review'

1. Introduction:

Cervical cancer is the fourth most common cancer among women worldwide (Bray et al., 2018. Effective prevention through cervical screening and vaccination programmes against the human papilloma virus (HPV) infection have resulted in lower cervical cancer prevalence in developed countries (Australian Institute of Health and Welfare, 2018; American Cancer Society 2018; Bray et al., 2018). However, financial constraints and lack of resources makes developing a consistent screening and vaccination programme difficult in developing countries (Markowitz et al., 2012). This means incidence and mortality is higher within those populations, and it is difficult to make comparisons between the developed and developing world in terms of their strategies to combat cervical cancer.

Screening contributes to reductions in incidence and mortality of cervical cancer, through early detection and treatment of precancerous cells (Public Health England (PHE), 2015). The United States (US) and Canada offer screening for women aged 21 years to 65 years (Canadian Partnership Against Cancer, 2016; American Cancer Society 2018) and Australia and the United Kingdom (UK) recommend screening for women aged 25-65 years (PHE, 2015; Australian Institute of Health and Welfare, 2018). The initial screening ages of countries in the European Union (EU) vary from 15 years in the Czech Republic to 30 years in Estonia and Finland (International Agency for Research on Cancer, 2017), moreover, some EU countries are yet to implement a population-based screening programme. Furthermore, it is widely accepted that the pathogenesis and development of cervical cancer is closely linked to the presence of the HPV infection (Bray et al., 2018), thus rendering HPV vaccination programmes effective at reducing risk of cervical cancer. By the end of 2006, the HPV vaccine was approved for use in 49 countries (Markowitz et al., 2012) to immunise women against HPV infection types 16 and 18; the variations of the infection that contribute most to cervical cancer development. The vaccine is effective in preventing HPV infection and screening abnormalities such as cervical intraepithelial neoplasia and cancer (Markowitz et al., 2012). Currently, the UK offers a school-based programme whereby girls ages 11-13 are routinely vaccinated, some other EU countries use this method, with nation health authorities funding all or parts of the vaccine (European Centre for Disease Prevention and Control (ECDC), 2012), however, age of initial vaccination and method of delivery varies greatly between EU countries. The US implementation varies between states and is covered by medical insurance. In Australia the HPV vaccine is part of the National Immunisation Programme and offered to school children aged 12-13 years (Australian Government

Department of Health, 2019). In conclusion, this demonstrates the widespread use of screening and vaccination in developed countries and their imperative role in reducing the prevalence and burden of cervical cancer.

Significant inequalities in the use of cervical cancer prevention strategies between socioeconomic groups are apparent globally (Pruitt and Schootman 2010; Fernández de Casadevante, Cuesta and Arevalo., 2015, Akinyemiju et al. 2016). This is evident even in countries where services are free at the point of use, such as the UK and Australia (Australian Institute of Health and Welfare, 2018; PHE, 2017), and where a re-call system is in place (Douglas, Waller, Duffy and Wardle, 2016). In 2015, only 73% of eligible women in the UK attended cervical screening (Health and Social Care Information Centre (HSCIC), 2015). Furthermore, despite clear evidence demonstrating HPV vaccination efficacy, there is reduced uptake amongst lower socioeconomic groups throughout Europe, the US and the UK (Fernández de Casadevante et al. 2015; Douglas et al., 2016).

Armstrong et al. (2012) demonstrated that women and girls refrain from engaging in health prevention due to lack of knowledge of the risks of cervical cancer and HPV. This, they contend, is often coupled with previous experiences or fears that hinder their decisions to attend. Nurses are central to coordinated public health efforts to prevent cervical cancer; they are the main providers of vaccinations and cervical screening and thus play a pivotal role in educating women and providing the information required to make an informed choice and increase uptake (PHE, 2017). Nurses are well placed to develop initiatives to reduce negative perceptions of screening or vaccination and can use research evidence to ensure women and girls are educated on the importance of health prevention strategies to improve future uptake (Armstrong et al., 2012; Johnson-Mallard et al., 2012).

Despite effective prevention strategies, cervical cancer is the fourth leading female cancer in incidence and mortality worldwide (Bray et al., 2018). From the most recent available dataset, cervical cancer caused 4,250 deaths in the USA in 2018 (American Cancer Society, 2018), 854 deaths in the UK in 2016 (Cancer Research UK, 2016) 230 deaths in Australia in 2015 (Australian Institute of Health and Welfare, 2018). Incidence and mortality are seen to be higher amongst women from lower socioeconomic groups (Cancer Research UK, 2016; American Cancer Society, 2018; Australian Institute of Health and Welfare, 2018), potentially stemming from the continued disparities in the uptake of prevention strategies between socioeconomic groups, despite efforts to reduce inequalities in uptake

globally (Douglas et al., 2016; Feldman, Davie and Kiran, 2017). This anomaly warrants further exploration. PHE (2017) assert that ensuring equity of access for organised screening and vaccination programmes should secure the current success of cervical cancer prevention. Previous studies have investigated socioeconomic status and its relevance to prevention uptake (Fisher, Trotter, Audrey, MacDonald-Wallis and Hickman, Fernández de Casadevante et al. 2015, Akinyemiju et al., 2016), but none have yet investigated the effect of the individual socioeconomic variables of education, income and occupation. Such an exploration may offer a greater level of detail and depth and could provide new insights to inform future practice and policy. A better understanding of what socioeconomic factors contribute to the equality gap in cervical cancer prevention should help with the development of targeted health education and promotion, thereby improving uptake. Ultimately this could lead to near eradication of cases of this potentially preventable disease.

2. Aims:

This systematic review aims to examine the association between socioeconomic factors, namely education, income and occupation, and cervical cancer screening and HPV vaccination uptake. The findings will help to identify gaps in research and provide critical information on the socioeconomic variables linked to uptake inequalities that adversely affect cervical cancer prevention strategies. This will aid the development and prioritisation of targeted cervical cancer prevention strategies, to increase uptake among eligible women, especially within populations with low level of uptake. Such insight is pivotal to tackling the highly preventable, treatable and curable cervical cancer burden.

3. Methods:

3.1 Research Design

The review aimed to evaluate the quality of literature on socioeconomic differences on uptake of cervical cancer prevention strategies. For this we undertook a systematic review using the PRISMA guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analysis (Supplementary File 1)) (Moher, Liberati, Tetzlaff, Altman and The PRISMA Group, 2009) and used the narrative synthesis guidelines outlined by Popay et al. (2006). We used the PEO (Population, Exposure, and Outcome) (Table 1) framework to construct the research question: 'How do education, income and occupation influence the uptake of cervical cancer prevention strategies in developed countries?'

3.2 Search strategy

We undertook an initial feasibility search, which found no recent similar reviews and supported the development of MeSH (Medical Subject Heading) terms and synonyms. The key subject terms were defined as 'socioeconomic variables', 'HPV vaccine', 'cervical screening' and 'inequalities'. Subject terms and synonyms of each were combined with truncations (*) and Boolean operators, 'AND' and 'OR', to limit and expand the search respectively (Table 2). Despite neighbourhoods and postal codes frequently used to determine socioeconomic status, variation among the three factors, education, income and occupation, comprising socioeconomic status, can significantly vary within neighbourhoods. Hence, why each individual socioeconomic factor was studied separately, thus reducing assumptions made for those woman and girls living in specific areas or postal codes.

3.3 Eligibility criteria

To retrieve papers, we searched five databases on 13/06/2018: Medical Literature On-Line (MEDLINE), Cumulative Index to Nursing and Allied Health Literature (CINHAL), PsychINFO, Science Citation Index and Healthcare Management Information Consortium (HMIC); an example is demonstrated in Table 3. Comprehensive eligibility criteria, along with justification behind each criterion (Table 4 and 5) were used to focus the search and yield only relevant papers. Cross sectional studies from 2006 to present completed in developed countries, using women and girls eligible for screening and vaccination and published in peer reviewed journal were included in the review. Studies including men, vulnerable groups, evaluating new intervention or prevention strategies, measuring intention rather than uptake uptake, not written in English or unpublished, were excluded. We also undertook hand-searches by scanning the reference lists of all selected papers and marked them against the eligibility criteria.

3.4 Search outcome

We combined the results of all searches and imported them into RefWorks, an online database management and reference software. A total of 1865 potential papers were identified through database searching (Medline = 573, CINHAL Plus = 271, PyschInfo = 115, Science Citation Index = 883, HMIC = 23), and eight papers through hand searching. After removal of duplicates, 905 papers remained. The titles and then abstracts were scrutinised against the eligibility criteria and 851 were excluded. We examined a total of 54

full texts against the eligibility criteria and of these, ten were suitable for inclusion in the review. This process is demonstrated by the PRISMA flow diagram (Figure 1), alongside justifications of exclusions.

3.5 Data analysis and narrative synthesis

Heterogeneity is defined by Higgins and Greene (2011) as the variability among studies combined within a systematic review, be it variability of design, outcomes measured, intervention effects or risk of bias among studies. Meta-analysis assumes data comes from a uniform population, however, in this review many baseline characteristics of the populations, countries, sample sizes and time periods were different. Furthermore, outcome measures, being classification of occupation, education and income and uptake of prevention strategies and differing statistical methods used to present datasets, led to the studies included in our review showing significant clinical and methodological heterogeneity (Higgins and Greene, 2011). Guidance suggests systematic reviews need not include a meta-analysis should heterogeneity be detected and datum should not be pooled for analysis, as assuming homogeneity may result in misleading analysis (Higgins and Greene, 2011; Kontopantelis, et al., 2013), in light of this, we adopted a narrative synthesis.

Narrative synthesis can be used when the studies are insufficiently similar to allow for other syntheses such as a meta-analysis. Guidance from Popay et al., (2006) was used to conduct the narrative synthesis. We evaluated the techniques advocated by the guidance to ascertain their relevance to our research question and synthesis and collectively made the appropriate adaptions to the guidance and selections of tools and techniques. For clarity, the stages of the narrative synthesis and location within the review are laid out in Table 6. The techniques used within each stage of the synthesis and justifications as to their relevance to our review are presented in Tables 7, 8 & 9.

3.6 Quality appraisal

The strength of evidence from which conclusions are drawn in a narrative synthesis should be identified (Popay et al., 2006) and the risk of bias within studies should be addressed (Moher et al., 2009). Therefore, we undertook a critical appraisal of the papers to assess the extent to which studies were free from bias and how much confidence could be placed in the findings (Higgins and Greene, 2011). Since all of the studies included in the review involved cross-sectional research, the AXIS (Appraisal tool for Cross-Sectional

Studies) (Downes, Brennan, Williams and Dean, 2016) tool was used. This enabled us to give a description after each question, and helped us to produce well thought out conclusions (Downes et al., 2016). The papers were subsequently rated based on the appraisal outcomes.

The outcomes of the critical appraisal (Table 10) were such that no papers were excluded on the basis of poor quality. Six studies were of moderate quality (Pruitt and Schootman, 2010; Tiro et al., 2012; Laz, Rahman and Berenson, 2013; Wei, Moore and Green, 2013; Ricardo-Rodrigues et al., 2015; Becerra-Culqui, Lonky, Chen and Chao, 2018) and four were high quality (Marlow, Waller and Wardle, 2008; Carrasco-Garrido et al., 2013; Hansen, Campbell, Burger and Nygard, 2015; Schulein et al., 2016). The results of the appraisal will be explored further using textual description and then taken into account when reviewing the findings, as more rigorous and reliable studies should be given greater scientific merit than weaker ones (Downes et al., 2016).

Sample sizes ranged from 90,842 to 994; large sample sizes were achieved through pooling of national datasets, found to be available from studies conducted in the US and Norway. No study or national datum set provided information of sample size estimates prior to collecting the datasets. This limits the strength of findings as the absence of sample size calculations could affect the generalizability of findings (Polit and Beck, 2014). Hansen et al. (2015) was the only paper that used all available datum for all eligible girls at the time the study was completed, increasing its reliability and strength (Polit and Beck, 2014). No studies were excluded due to lack of sample size calculation or based on the sample size, as to do so could introduce systematic bias (McDonagh, Peterson, Raina, Chang and Shekelle, 2013).

Many of the included studies used self-reported datum which could bring about recall bias, as accuracy relies upon participants to correctly recall past events and can negatively affect internal validity and credibility of studies (Polit and Beck, 2014). Hansen et al. (2015) and Beccera-Culqui et al. (2018) were the only studies to use datum which was not self-reported, therefore negating concerns of recall bias. Evidence shows that self-reporting of cancer screening is generally accurate and a valid method of data collection (Ferrante et al., 2008), therefore whilst possibly affecting results, recall bias should not diminish their credibility.

Non-response bias can be introduced when a subset of people, who may share similar characteristics, decline to participate (Polit and Beck, 2014). Hansen et al (2015) and Beccera-Culqui et al (2018) showed no non-response bias as results were entered through use

of a national datum set rather than self-report. As cervical screening and vaccination is considered a sensitive topic this increases the likelihood participants may give incomplete or socially desirable answers, contributing to bias (Edwards et al., 2002; Sedgwick, 2014). No studies attempted to improve response rates, and thereby reduce bias, by following up non-respondents or missing datum (Edwards et al., 2002). Furthermore, it is difficult to quantify the extent of non-response bias because of the limited detail of the characteristics of non-responders (Sedgwick, 2014). To minimise this bias, response rates should be high (Sedgwick, 2014), which was evident in some studies (Laz et al., 2013; Carrasco-Garrido et al., 2014; Hansen et al., 2015, Beccera-Carrido et al., 2018). Although some studies had low response rates (Tiro et al., 2008; Schulein et al., 2016), all considered the effects of potential bias. However, Pruitt and Schootman, (2010) and Wei et al. (2013) did not report the response rate, therefore limiting the judgement of bias. Despite this, reassurance of the representativeness of the sample was given throughout all studies.

All studies used samples that were representative of the target population. Many of the studies used national survey datum or electronically recorded medical datum (Pruitt and Schootman, 2010; Tiro et al., 2012; Laz et al., 2013; Wei et al., 2013; Carrasco-Garrido, 2014; Hansen et al., 2015; Ricardo-Rodrigues et al., 2015; Beccera-Culqui et al., 2018), which ensured their samples reflected that of the true population. Random sampling was commonly used (Marlow et al., 2008; Pruitt and Schootman, 2010; Tiro et al., 2012; Ricardo-Rodrigues et al., 2014) improving objectivity and reducing selection bias. Marlow et al. (2008), Schulein et al. (2016) and Tiro et al., (2012) addressed concerns of non-response by weighting datum or purposively recruiting for any underrepresented characteristics, this assured a representative sample allowing for generalisability of findings. Beccera-Culqui et al. (2018), however, used datum of women who were members of one health insurance scheme in the US, therefore the transferability of findings is compromised since various schemes exist in the US and their different terms may influence women's decisions to be screened. Despite this, the majority of studies used representative samples, allowing findings to be transferable to the wider population and used in future national interventions to promote cervical cancer prevention strategies.

In summary, all studies were of good quality, using appropriate data collection methods, partially addressing non-response and having samples representative of targeted women. Therefore, all studies were carried forward into the synthesis of this systematic review.

4. Results:

Raw datum from the studies were extracted and tabulated as the starting point to the synthesis. The Cochrane Review 'characteristics of included studies' table (Higgins and Greene, 2011) was used as a base for the table format with additional columns added when deemed appropriate to the studies. We developed an extraction table and piloted it on two papers; subsequently the key information and raw datum from each paper were then identified and tabulated (Tables 11 & 12). Logistic regression was used in all studies as a means of calculating the odds ratio (OR) and confidence intervals (CI). Key statistical datum for each variable and statistical significance reported in each paper was extracted and tabulated (Tables 13, 14, 15 & 16). All this information was textually summarised throughout the review to allow for in depth exploration of relationships and key elements and to ensure that we did not over-rely on dataset extraction tables and thus overlook important findings.

4.1 Summary of studies

All studies used a cross-sectional design, suitable for exploring descriptive quantifiable aspects of healthcare (Polit and Beck, 2014). Five studies were conducted in the US (Pruitt and Schootman, 2010; Tiro et al., 2012; Laz et al., 2013; Wei et al., 2013; Becerra-Culqui et al., 2018), two in Spain (Carrasco-Garrido, 2014; Ricardo-Rodrigues et al., 2015), and one each in Germany (Schuilein et al. 2016), the UK (Marlow et al., 2008), and Norway (Hansen et al., 2015). Cervical screening uptake was studied in four papers (Marlow et al., 2008; Carrasco-Garrido et al., 2014; Ricardo-Rodrigues et al., 2015; Becerra-Culqui et al., 2018) and HPV vaccination uptake was studied in six papers (Pruitt and Schootman, 2010; Tiro et al., 2012; Laz et al., 2013; Wei et al., 2013; Hansen et al., 2015; Schulein et al., 2016). All but two studies (Laz et al., 2013; Hansen et al., 2015) reported initiation not completion of HPV vaccination. This highlights a need for follow up to completion of the vaccine as the results from Laz et al., (2013) and Hansen et al., (2015) showed some failure of participants to complete the three dose course.

All studies identified the target sample as those eligible for screening or vaccination. Screening and vaccination uptake was defined as per the guidelines of the country in which the studies took place. All studies measured education as a socioeconomic factor, eight measured income (Marlow et al., 2008; Pruitt and Schootman, 2010; Tiro et al., 2012; Laz et al., 2013; Wei et al., 2013; Schuilein et al. 2016; Hansen et al., 2015; Becerra-Culqui et al., 2018) and two measured occupation (Wei et al., 2013; Hansen et al., 2015). Education was

mostly measured by level of education attained, categorised into groups ranging from two to five categories. Income was measured through monthly or annual income, percentage income from the federal poverty level, or in increasing levels of income. Occupation was measured, as employed or not employed, or by nature of occupation. Studies measuring HPV vaccination uptake often used maternal socioeconomic factors rather than those of the girls receiving the vaccine.

4.2 Overall uptake

In all studies more than 65% of women regularly attended cervical screening; the highest uptake was reported by Marlow et al. (2008) in the UK, with 89% attendance. Vaccination initiation was dramatically lower than screening uptake. The majority of studies found uptake in <40% of girls, with the exception of Hansen et al. (2015) where 78.2% initiated and 74.6% of the population completed the HPV vaccination.

4.3 Education

All studies concerned with screening, except Becerra-Culqui et al., (2018), found a positive relationship between level of education and screening uptake. Particularly, Carrasco-Garrido et al. (2013) and Ricardo-Rodrigues et al. (2014) found those with a university education were twice as likely to be screened when compared to those with a primary education (OR: 2.03, CI: 1.60-2.58, OR 2.59, CI: 1.97-3.40, respectively). Becerra-Culqui et al. (2018) found no association between education and screening uptake.

Within studies measuring HPV vaccination, all studies but Hansen et al. (2015) found mothers with lower education less likely to initiate the vaccine for their daughters. Pruitt and Schootman (2012), Tiro et al., (2012) and Laz et al., (2013) found education to be highly significant ($p<0.01$) to initiation of vaccination. Conversely, Hansen et al. (2015) found education and vaccine initiation to have a negative relationship, whereby mothers with primary education were more likely to initiate the vaccine in daughters (OR: 1.36, CI: 1.10-1.65) and those with postgraduate education less likely (OR: 0.89 CI: 0.82-0.96) when compared to those with upper secondary education. The majority of studies (Pruitt and Schootman, 2012; Tiro et al., 2012; Hansen et al., 2015; Schulein et al., 2016), found that there was a significant positive relationship between the highest levels of education and vaccination uptake compared to lowest educational levels but there were no significant

differences between similar levels of education, such as high school and college or primary and lower secondary.

Some countries, such as the UK, Australia and other EU countries, have vaccination programmes in place whereby vaccines are given routinely by public health or school nurses (ECDC, 2012; HSCIC, 2015; Australian Government Department of Health, 2019). This concept may vary between and within countries, potentially leading to reduced inequality between girls who are being vaccinated and those that are not. This is due to the fact within developed countries all girls must attend school regardless of socioeconomic status thus are made eligible for the vaccine and have free, easy access to the vaccination. However, parental consent to these vaccinations is warranted, therefore, studying parental socioeconomic status in relation to HPV vaccination deems justifiable.

4.4 Income

Two studies considered screening uptake and income (Marlow et al., 2008; Beccera-Culqui et al., 2018). Marlow et al. (2008) did not find a significant relationship between screening uptake and income ($p=0.351$). However, Becerra-Culqui et al. (2018) found income to be strongly statistically significant with cervical screening ($p<0.001$), with those women with the highest income more likely to attend screening (OR 1.07, CI 1.03-1.11).

Income was measured as a variable by all studies exploring HPV vaccination initiation and was found to be statistically significant in four out of six studies (Pruitt and Schootman., 2010; Tiro et al., 2012; Wei et al., 2013; Hansen et al., 2015). Three of the four studies carried out in the US found income to be significant in relation to vaccination (Pruitt and Schootman, 2012; Tiro et al., 2012; Wei et al., 2013). Laz et al. (2013) found no statistical significance between income and vaccination, however, results indicated those women with a family income of <100% of the federal poverty line (FPL) were less likely to receive the vaccination than those whose family income was ≥200% of the FPL. Hansen et al. (2015) and Schulein et al. (2016) both demonstrated that those in lower income groups were almost half as likely to initiate the vaccine than those in the highest income groups. Conversely, Pruitt and Schootman (2010) identified a negative correlation between income and vaccination, as those with lower incomes when compared to those with the highest income, were more likely to initiate vaccination (OR: 1.53, CI: 1.06-2.21). Whereas, Wei et al. (2013) and Tiro et al (2012) found girls from lower income household were less likely to have initiated the vaccine (OR: 0.73, CI: 0.68-0.78 and OR: 0.87, CI: 0.55-1.40,

respectively), similar to the outcomes found by Laz et al. (2013). Much like education, the findings demonstrate considerable difference between highest and lowest groups but little variation between similar groups of income.

4.5 Occupation

Occupation was not measured in any of the papers studying screening uptake and was measured by two studies addressing HPV vaccination initiation (Wei et al., 2013; Hansen et al., 2015). Hansen et al. (2015) reported that mothers either in education, retired or stay-at-home parents compared to employed mothers were less likely to initiate the vaccine in daughters (OR: 0.72, CI: 0.68-0.77). However, mothers who were unemployed (OR 0.89, CI: 0.75-1.06) or employed in managerial, professional or associate positions (OR: 1.04, CI: 0.99-1.09) were neither less nor more likely to initiate vaccination than those employed. However, neither study found occupation to be statistically significant in vaccination initiation. Overall, the studies demonstrate a gap in research on occupation and uptake of cervical screening and HPV vaccination.

4.6 Limitations

Acknowledging the limitations of research allows findings to be more applicable. A meta-analysis was not suitable in this review and thus we embarked on a narrative synthesis, which whilst appropriate, can introduce subjectivity and potentially reduce credibility (Polit and Beck, 2014). We took measures to minimise subjectivity by using a systematic approach following well regarded guidelines (Moher et al., 2009; Popay et al., 2006). We only retrieved published papers to inform this review and we did not explore grey literature, so readers should be aware of potential publication bias, as journals tend to favour articles with significant findings (McDonagh et al., 2013). We excluded studies that were completed in developing countries and therefore the results of this review are not transferable to those countries. Finally, only cross-sectional studies were retrieved, and this means that causality cannot be deduced and only correlational relationships can be confirmed. Therefore, any future interventions that are solely based on this review should be introduced with caution.

Only studies published and using results after 2006 were included in the review and therefore any findings can contribute to up to date evidence, and professionals can rely upon this as evidence for best practice (Polit and Beck, 2014). Incorporating specific socioeconomic variables allowed a more detailed comparison between them and the extent to

which they all contribute to the inequalities seen in cervical cancer prevention uptake. Lastly, this review includes studies from countries of a similar economic standing, and the retrieved research was of good quality and generalisable, therefore enabling transferability of findings between developed countries.

5. Discussion:

In this review, we aimed to explore the socioeconomic factors, education, income and occupation and their association to uptake of cervical screening and HPV vaccination among eligible women within developed countries. The published research was of sound quality and provided evidence on the relationships between socioeconomic variables and cervical cancer prevention uptake. All studies took place in the US, UK or Europe, highlighting a gap in research of the uptake of cervical cancer prevention and socioeconomic variables in economically similar countries such as those in Australia, New Zealand or Canada. Further research in a wider range of countries would allow greater comparisons to identify potential patterns in uptake.

Overall uptake of screening varied. Cervical screening attendance in the UK and Spain was higher, as demonstrated by Marlow et al. (2008), Carrasco-Garrido et al (2013) and Ricardo-Rodrigues et al (2014), in comparison to economically similar countries like the US as found by Becerra-Culqui et al (2018). One explanation for this is that the UK and other EU countries adopt a free recall system (HSCIC, 2015), However, since screening uptake has reduced over the past decade, (HSCIC, 2015), there is room for improvement in these structured programmes across the UK and Europe and other strategies to augment uptake need consideration. There is a suggestion that negative experiences of screening and vaccination such as embarrassment, discomfort in exposing an intimate part of the body, poor body image, pain, surrendering control and time constraints may impact negatively on future decisions to participate (Armstrong et al., 2012). These factors may explain why some women do not partake in screening despite well-structured programmes. Therefore, a predominant research priority for primary care nurses, who are at the forefront of health promotion and cervical screening, should be on how the physical and psychological experience of screening can be improved to increase uptake.

Our review shows that the uptake of HPV vaccination is significantly lower than that of cervical screening. This may seem counterintuitive, given the more intrusive and intimate nature of screening. However, since screening programmes have been in place in developed

countries for some 25 years, they may have become more embedded and accepted by women than have vaccinations, for which programmes came into force more than a decade later. Moreover, the decision to take up cervical screening is that of the individual adult, whereas child vaccination, requires both individual and parental consent and this may dilute the level of uptake. In this systematic review, Hansen et al. (2015) found the highest uptake of vaccination initiation in their Norway based study. All studies based in the US (Laz et al., 2013; Pruitt and Schottman, 2010; Tiro et al., 2012; Wei et al., 2013) showed more girls were not vaccinated than were vaccinated. Schulein et al (2016) found similar results in Germany to those in the US. The UK, Australia and some EU countries recommend vaccination in girls ages 10-14 and catch-up vaccinations for those that missed it; furthermore, the UK and many EU countries fully or partly fund the vaccine from national health authorities, which may be of benefit in other countries to improve uptake (ECDC, 2012; Australian Government Department of Health, 2019). However, target age, financing and delivery programme varies between EU countries, some commence vaccination in girls aged 10, and some at 14 years (ECDC, 2012). Additionally, many of these countries have implemented a school-based programme for vaccination, including Norway but not including Germany, which could explain the differences in uptake between these two EU countries (ECDC, 2012). Furthermore, Germany relies on private infrastructure to deliver the vaccine. Whereas the US implementation varies between states, in terms of insurance cover and recommendations to have the vaccine; some states requires by law girls are vaccinated, others have no school-based programme. Walling et al., (2016) showed in their review that school-based strategies, like the Norway programme, increase vaccination rates. This is because, amongst other things, endorsement by schools help to reinforce the importance of the vaccination, good school communication strategies help to gain parental consent and delivery by experienced and skilled school nurses is key to high uptake (Perman et al., 2017). Overall, this suggests that the methods and structure of prevention programmes contribute to the differences in uptake and implementing population-based strategies improves initiation.

5.1 Education

Overall, our review findings suggest that level of education is of great significance to screening uptake and vaccination initiation; generally, a higher level of education increases the likelihood of partaking in these strategies. Lower levels of education can constrain health literacy because of a limited ability to read and fully comprehend the given information (Oldach and Katz, 2015). Health literacy is found to be associated with knowledge in relation

to screening (Lindau et al., 2002) and a contributing factor to autonomy and empowerment and hence, decisions to consistently adhere to cervical cancer screening guidelines (Oldach and Katz, 2015). Despite this, it is evident that knowledge of the HPV virus is limited even in countries such as US and UK with well-developed health promotion strategies, where audience segmentation and tailored messages is commonplace (Marlow, Zimet, McCaffery, Ostini and Waller, 2013). One-on-one education and reminders have been recommended to improve screening uptake, as well as structured, organised mass screening, as women of lower education have been shown to be more adherent to these strategies (Damiani et al., 2012). Furthermore, much like school-based vaccination programmes, population-based programmes to deliver mass screening may improve uptake and diminish inequalities between differing education groups. Therefore, nurses need to develop interventions that take account of low literacy levels among girls and women to improve uptake (Lindau et al., 2002).

All but two of the studies, demonstrated that higher levels of education lead to greater uptake in prevention practices. Hansen et al. (2015) and Becerra-Culqui et al. (2018) were the exception here. Becerra-Culqui et al. (2018) measured education within census blocks, and did not focus specifically on the education attained by individuals, which could have led to the anomalous results. Furthermore, their study included women belonging to an insurance scheme, which limits transferability to other populations. As might be expected, Fisher et al. (2013), found uninsured women were less likely to complete HPV vaccination and this could also contribute to the atypical results of the Becerra-Culqui et al. (2018) study. This highlights the significance that confounding factors such as insurance may have on screening and vaccination. To strengthen this explanation further, Hansen et al (2015) offered confounding variables as an explanation for their unusual findings.

The setting in which vaccination are administered has been shown to contribute to uptake (Fisher et al., 2013). Most HPV vaccinations take place in schools (PHE, 2015; Walling et al., 2016) where eligible girls, not just their mothers or guardians, receive health education on the importance of vaccinations. School nurses are in a prime position to promote and educate parents and girls on the importance of vaccination (Perman et al., 2012). Indeed, Moghtaderi and Adams (2016) found that mandates and policies were less effective in promoting HPV vaccination than encouraging recommendations by healthcare professionals. This could be due to the respect given to nurses which enhances their ability to influence health related decision making (Johnson-Mallard et al., 2012).

In summary, a lower education level reduces the likelihood of screening uptake and vaccine initiation because low literacy limits the response to generic population-based health education strategies. However, the setting and implementation of prevention, such as school-based programmes should be considered to increase uptake. Future research should seek to explore interventions aimed at improving health literacy and health education and consider the role of school nurses and primary care nurses in such approaches.

5.2 Income

Level of income has significant links to health behaviours; lower levels of income generally increases the likelihood of negative health behaviours (Pampel, Krueger and Denney, 2010). Financial problems may lead to an inability to pay for health promoting material (Pampel et al., 2010), particularly in systems where there is a charge for health care, such as in the US (American Cancer Society, 2018). Within countries such as the UK and Australia and some EU countries, screening and vaccination comes as part of a healthcare system that is free at the point of delivery with national health authorities either fully or partly funding costs and these countries show higher uptake (Marlow et al., 2008; ECDC, 2012; HSCIC, 2015; Australian Government Department of Health, 2019). However, a socioeconomic health divide is still evident with those from lower incomes less likely to initiate vaccination and have reduced knowledge and awareness of HPV and vaccination, as demonstrated by Marlow et al (2013) in the US, UK and Australia; furthermore, across the UK, US and Australia knowledge of HPV and vaccination were poor. Therefore women from lower income level are less likely to adhere to programmes, suggesting levels of income may affect uptake in ways other than the individual cost of healthcare. This points to the important role that nurses and healthcare professionals on the frontline have in educating women and girls from different backgrounds.

Additionally, future exploration into geographical deprivation and uptake of preventative health programmes may be beneficial, as lower income areas are more likely to have inadequate health care facilities (Pampel et al., 2010). Overall, removing the cost of screening and vaccination may reduce inequalities brought about by income difference. However, other variables such as living in a lower income geographical area and lower health literacy as a consequence of lower income, should also be considered, thereby enabling health promotion and education to be targeted to these identified populations.

Removing the costs of prevention strategies for the individual may reduce the inequalities seen between different income levels. However, we know that this is limited by a country's resources and by the political will to address this issue. And we know that nurses are reluctant to embrace a political role in promoting health (Kemppainen et al., 2012). Yet if nurses are to help strengthen prevention strategies, then they have a duty to provide evidence on best practice, and that includes evidence that challenges political policy (Whitehead 2011).

5.3 Occupation

The two studies in this review that considered mothers' occupation found it to be of little significance to their decisions to consent to their daughters being vaccinated. That said, occupation and its association to preventative health uptake may still be of interest to public health practitioners, as it has been shown to impact on the mortality rates of cervical cancer (Slack, Young and Rushton, 2012). Interventions could be aimed at specific occupational groups to target similar groups of women with low uptake (Slack et al., 2012). However, since this is an under-explored area, there is a need for more research before we fully understand the place of occupation in cervical cancer prevention.

6. Conclusion:

The results from this systematic review lead to the conclusion that socioeconomic factors are associated with cervical cancer screening uptake and the initiation of the HPV vaccination. The strength and direction of their relationships is variable between countries, potentially stemming from different methods of implementing prevention strategies. Education appears to have more impact on prevention uptake than income, and occupation shows no significance. However, limited research into occupation and its association makes this difficult to confirm. Future research should explore barriers and develop interventions to increase uptake among those populations with lower adherence. Overall, public health interventions and changes to policies to increase cervical cancer screening uptake and the initiation of the HPV vaccination could be targeted at groups with specific socioeconomic variables.

7. Relevance to Clinical Practice:

Our review shows that socioeconomic factors have an association with the uptake of cervical cancer prevention strategies. However, there is variability in the significance that

education, income and occupation individually have on uptake between countries, possibly because of varying healthcare systems, costs and programmes. That said, nurses can use the findings of this review to improve uptake and target interventions towards women and girls who, wherever in the developed world, are disinclined to take part in cervical cancer prevention programmes, such as those with lower levels of education and lower income.

We have highlighted the fact that nurses have a pivotal role in relaying the important risks and benefits of partaking in cervical cancer prevention strategies to patients; and they are ideally placed to promote healthy behaviours to women and girls. Thus they should be fully conversant with the relationship between individual socioeconomic variables and the uptake of cervical screening and HPV vaccination. And they should use this information to ensure that they tailor their prevention programmes to address the specific needs of their target audience of eligible women and girls. More research is needed to tease out the impact that different interventions, such as health education or school-based vaccination have on particular socioeconomic groups, to inform future prevention strategies. Investing effort in improving health literacy, health education and accessibility of screening and vaccination can increase women's knowledge of prevention strategies, promote autonomy and empower women and consequently improve the uptake of screening and vaccination. Increasing uptake would mean that cervical cancer prevention strategies have the potential to eliminate the preventable burden of cervical cancer to women across entire nations.

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Table 1: Research question following the PEO framework

Population	**Exposure**	**Outcome**
Women and girls who would be eligible according to the criteria in their country of residence for cervical cancer screening and HPV vaccination	Education Income Occupation.	Relative uptake of cervical cancer prevention methods.

Table 2: Keywords and Boolean operators included in the search

	Keywords		
	Socioeconomic variables	**Cervical cancer prevention strategies**	**Inequalities**
Boolean operators	**AND**	**AND**	**AND**
OR	Socioeconomic	Cervical cancer screen*	Inequalities
OR	Socio-economic	Cervical smear	Inequality
OR	Socioeconomic status	Vaginal smear	Health status disparities
OR	Socioeconomic factor*	Pap smear	Barrier*
OR	Social class	Papanicolaou test	Adherence
OR	Social status	Smear test	Compliance
OR	Socioeconomic position	Cervical screen*	Concordance
OR	Education	HPV vaccine*	Guideline adherence
OR	Occupations	HPV vaccination	Health services accessibility
OR	Income	Papillomavirus vaccine*	
OR	Depriv*		
OR	Employ*		

**Indicate where truncations used*

Table 3: Search strategy example from MEDLINE

Search terms		Results
1	Socioeconomic	189236
2	Socioeconomic status	36582
3	Socioeconomic factor*	145981
4	Social class	37293
5	Social status	5096
6	Socioeconomic position	2382
7	Education	19790
8	Occupations	21982
9	Income	109843
10	Deprivation	94556
11	Poverty	51256
12	Employ*	536019
13	1 OR 2 OR 3 OR 4 OR 5 OR 6 OR 7 OR 8 OR 9 OR 10 OR 11 OR 12	950306
14	Cervical cancer screen*	5317
15	Cervical smear*	1300
16	Vaginal smear*	21363
17	Pap smear	4054
18	Papanicolaou test	6089
19	Smear test	692
20	Cervical screen*	2550
21	HPV vaccine	4374
22	HPV vaccination	3424
23	Papillomavirus vaccines	6398
24	Human papillomavirus vaccine	1249
25	14 OR 15 OR 16 OR 17 OR 18 OR 19 OR 20 OR 21 OR 22 OR 23 OR 24	35171
26	Inequality	14293
27	Inequalities	15608
28	Health status disparities	12325
29	Barrier*	249650
30	Adherence	127399
31	Compliance	3902
32	Concordance	37420
33	Guideline adherence	28267
34	Health service accessibility	65311
35	26 OR 27 OR 28 OR 29 OR 30 OR 31 OR 32 OR 33 OR 34	496787
36	13 and 25 and 35	823
	Limit 36 to (abstracts and English language and yr=”2006-Current”)	585

**Indicate where truncations used*

Table 4: Inclusion criteria

Inclusion criteria	**Rationale**
Studies undertaken in developed countries.	Developed countries were studied on their own, based on evidence of the complexity of implementing a cervical cancer prevention strategy that is feasible globally; many developed countries do not offer the HPV vaccine due to lack of available resources (Markowitz et al., 2012).
Studies researching general populations of women, eligible for screening and vaccination.	These will mean the results are generalizable to other populations rather than a specific group; an important goal within quantitative research (Polit and Beck, 2014), additionally findings can be used in future policy and programme decision-making when targeting whole populations.
Studies using a cross-sectional study design.	This review focusses on cross-sectional studies as this is recommended for descriptive quantitative questions (Polit and Beck, 2014)
Studies in which outcome measures are uptake of cervical screening or HPV vaccination alongside socioeconomic variables, being education, income and occupation. Include parental measures of these socioeconomic variables.	Research question aims to identify the socioeconomic variables that coincided with current prevention uptake and not to measure the effectiveness of new strategies. Young girls will have not yet finished education or have an income or occupation, therefore their parent/guardian is the next most accurate measure.
Studies published and using data from 2006 to present day.	Date range restricted as the HPV vaccine was initially introduced in 2006, in Canada, Australia and Austria.
Studies published in peer reviewed journals.	Unpublished work may introduce bias to the review therefore reduced validity (McDonagh et al., 2013)

Table 5: Exclusion criteria

Exclusion criteria	**Rationale**
Studies examining or including men within socioeconomic variables and uptake of prevention strategies.	There is debate whether it is beneficial to vaccinate men and only some countries vaccinate adolescent boys, as the US and UK do not, exclusion of men was deemed appropriate (PHE, 2015). Furthermore, cervical screening is only applicable to women.
Studies researching vulnerable groups within the wider population, such as immigrants, or those with a co-existing medical condition such as HIV.	Being vulnerable may limit or increase access to services and would not allow transferability of findings.
Studies measuring implementation of new strategy of cervical cancer screening or vaccination and prevention methods. Or comparing methods, i.e. experimental research.	The aim to review current practices of cervical cancer prevention strategies and not the effectiveness of interventions.
Studies not written in the English language	Due to restrictions on time and funding, translation of articles would not be achievable.
Studies measuring willingness or intention of uptake of cervical cancer prevention methods.	These studies do not measure actual uptake, therefore no definite figures and patterns are revealed.
Unpublished materials	Can introduce bias and be of lower methodological rigour (Higgins and Greene, 2011).

Table 6: Narrative synthesis

Element of the synthesis	**Aim of the technique and location within the review**
Developing a theoretical model	Aims to inform decisions about the studies included. Explored in the background and method sections.
Developing a preliminary synthesis	Aims to organise the findings from the review and describe patterns, directions and size of effects. Explored in the results section.
Exploring relationships in the data	Aims to consider factors that explain direction and size of effects across the studies, alongside the relationships between the studies. Explored in the discussion section.
Assessing the robustness of the synthesis product	Aims to provide an assessment of the strength of the evidence for drawing and generalising conclusions made, along with recognising the measures to minimise bias in the systematic review. Explored in the quality appraisal and limitations section.

Underlined words indicate sections within the review

Table 7: Developing a preliminary synthesis

Tool/technique	**Comments in relation to current synthesis**	**Should this tool/technique be applied here?**
Textual descriptions	Used to identify which aspects of the studies will be drawn from in the review. May link to table headings. Used to summarise studies and begin to explore relationships and extract data	Yes, see results
Groupings and cluster	Not applicable due to the smaller number of studies included in the review.	No
Transforming data, constructing a common rubric	Not applicable as the reported data already relates to one another.	No
Translating data	Not applicable due to all data being quantitative	No
Tabulation	Study characteristics and results will be described. Using the textual descriptions to expand on any important aspects of individual studies	Yes, see Tables 10, 11, 12, 13 & 14
Vote-counting as a descriptive tool	As all data are comparable and significance can be drawn from each study vote-counting would prove useful. The use of ticks and arrows allowed clearer descriptions of the strength and direction of statistical significance identified in the studies	Yes, see Table 15

Table 8: Exploring relationships within and between studies

Tool/technique	**Comments in relation to current synthesis**	**Should this tool/technique be applied here?**
Moderator variables and subgroup analyses	Exploring each socioeconomic factor individually and comparing characterises of outcomes and population groups between studies.	Yes
Idea webbing/conceptual mapping	Relationships between and within studies are explored in other techniques.	No
Conceptual triangulation	Through grouping findings this technique is woven throughout the review.	Yes
Reciprocal translation	No qualitative evidence used	No
Qualitative case description	No qualitative evidence used	No
Visual representation of relationship between study characteristics and results	The small number of studies within each category would prove visual representations to be largely uninformative	No
Investigator and methodical triangulation	As all studies were cross-sectional there should be no systematic differences in results.	No

Table 9: Assessing the robustness of the synthesis

Tool/technique	**Comments in relation to current synthesis**	**Should this tool/technique be applied here?**
Best evidence synthesis	Not applicable as this tool looks at the selection of studies and all studies in this review are cross-sectional	No
Use of validity assessment	As all studies were cross-sectional the AXIS tool was deemed appropriate to appraise each study.	Yes, see Table 16
Checking the synthesis with the authors of primary studies	Not applicable as data yielded for many studies was not primary	No
Reflecting critically on the synthesis process	This is done throughout this process, exploring the methodology, validity, generalisability, influences and assumptions throughout the review.	Yes

Table 10: Critical appraisal summary

Author(s) (year)	Introduction	Methods									
	Were the aims/objectives of the study clear?	Was the study design appropriate?	Was the sample size justified?	Was the target population clearly defined?	Was the sample taken from appropriate population base.	Was the selection process selects representative	Were measure taken to address non-responders?	Were the outcome variables measured appropriately?	Were the outcome variable measure using valid tool?	Is it clear what determined statistically	Were the methods sufficiently described?
Becerra-Culqui et al., 2018	✓	✓	×	✓	✓	✓	×	✓	✓	?	✓
Carrasco-Garrido et al. (2013)	✓	✓	×	✓	✓	✓	×	✓	✓	✓	✓
Laz et al. (2013)	✓	✓	×	✓	✓	✓	×	✓	✓	✓	✓
Marlow et al. (2008)	✓	✓	×	✓	✓	✓	✓	✓	✓	?	✓
Ricardo-Rodrigues et al. (2015)	✓	✓	×	✓	✓	✓	×	✓	✓	✓	✓

Hansen et al. (2015)	✓	✓	N/A	✓	✓	✓	N/A	✓	✓	?	✓
Pruitt and Schottman (2010)	✓	✓	✗	✓	✗	✓	✓	✓	✗	✓	✓
Schulein et al. (2016)	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓	✓
Tiro et al. (2012)	✗	✓	✗	✓	✓	✓	✓	✓	✓	✓	✓
Wei et al. (2013)	✓	✓	✗	✓	✓	✓	✗	✓	✓	✓	✓

Author (year)	**Results**					**Discussion**		**Other**		**Quality rating**
	Were the basic data adequately described?	Does the response rate diminish concerns of non-	Was information about non-responders described?	Were the results internally consistent?	Were the results for analyses presented?	Were discussions and conclusions justified by	Were the limitations discussed?	If there were funding sources or conflicts of interest, did	Was ethical approval or consent gained?	
Becerra-Culqui et al., 2018	✓	✗	✗	✓	✓	✓	✓	?	N/A	**Moderate**

Carrasco-Garrido et al. (2013)	✓	✗	✓	✓	✓	✓	✓	✓	N/A	**Strong**
Laz et al. (2013)	✓	✗	✗	✓	✓	✓	✓	✓	N/A	**Moderate**
Marlow et al. (2008)	✓	✗	✓	✓	✓	✓	✓	?	✓	**Strong**
Ricardo-Rodrigues et al. (2015)	✓	✗	✗	✓	✓	✓	✓	✓	N/A	**Moderate**
Hansen et al. (2015)	✓	N/A	N/A	✓	✓	✓	✓	✓	✓	**Strong**
Pruitt and Schottman (2010)	✓	?	✗	✓	✓	✓	✓	?	?	**Moderate**
Schulein et al. (2016)	✓	✓	✓	✓	✓	✓	✓	?	✓	**Strong**
Tiro et al. (2012)	✓	✗	✗	✓	✓	✓	✓	✓	✓	**Moderate**
Wei et al. (2013)	✓	?	✓	✓	✓	✓	✓	?	?	**Moderate**

Key: ✓ = Yes; ✗ = No; ? = Unclear; N/A = not applicable

Table 11: Data extraction for papers measuring cervical screening uptake

Author(s) (year)	Country	Population, sample size (N) sampling method	Data source, year, method	Socioeconomic variables measured (n= number of groups within each variable)	Measure of uptake of prevention strategy	Data analysis, statistical significance	Limitations
Becerra-Culqui et al. **(2018)**	United States	Women aged 21 between Jan 2013- Dec 2015 N=38,257 Convenience sample	Female members, of Kaiser Permanente Southern California 2016 Electronic health records	Education level (3) Income (3)	Initiation of cervical screening	Chi squared. Confidence intervals based on Poisson regression. Not stated	Not generalizable to uninsured women. Unrecorded refusal or decline of screening. The study represent early findings after the guidelines were released, hence may not have taken full effect yet.
Carrasco-Garrido, et al. **(2014)**	Spain	Spanish women aged 25-64 years. N= 4040	Oncobarometro Survey conducted by Fundacion de la Asociacion Espanola Contra el Cancer (2010)	Education level (3)	Uptake of screening within the previous 2 years	Chi squared or Fisher's exact test. Logistic regression analysis. STATA Statistical	Uses self-reported data. Results may be influenced by non-response bias or socially desirable responses given

Author(s) (year)	Country	Population, sample size (N) sampling method	Data source, year, method	Socioeconomic variables measured (n= number of groups within each variable)	Measure of uptake of prevention strategy	Data analysis, statistical significance	Limitations
		Detail not given	Home-based personal interview			significance at $p<0.05$	Over educated, hence more health conscious may be over-represented. Causality cannot be inferred. Insurance type is not covered & may affect results if associated with screening.
Marlow, et al. (2008)	United Kingdom	British women aged 25-64 years. N= 994 Stratified random probability	Survey using questions from the National Centre for Research omnibus survey (2008) Face-to-face interviews.	Education level (2) and income (3)	Uptake of screening	Logistic regression. Uses SPSS version 14.0. Not stated	Response rate was not high. Social desirability bias. Women who generally 'take-part' more may be over-represented.

Author(s) (year)	Country	Population, sample size (N) sampling method	Data source, year, method	Socioeconomic variables measured (n= number of groups within each variable)	Measure of uptake of prevention strategy	Data analysis, statistical significance	Limitations
		sampling					
Ricardo-Rodrigues, et al. **(2015)**	Spain	Spanish women aged 25-65 years. N= 7022 Random sampling	Spanish National Health Survey, (2011) Personal home-based interviews	Education level (3)	Uptake of screening as 'I regularly have cervical cancer screening' , within the last 3 years	Chi squared tests. Logistic regression. Uses STATA version 9.1. Statistical significance at $p<0.05$	Response was higher among older women, those with higher education and non-Spanish nationality. Screening may be more easily accessed by women with higher income and higher education level. Therefore results are likely to overestimate uptake of screening.

Author(s) (year)	Country	Population, sample size (N) sampling method	Data source, year, method	Socioeconomic variables measured (n= number of groups within each variable)	Measure of uptake of prevention strategy	Data analysis, statistical significance	Limitations
							Cross-sectional design means no causality can be deduced. Self-reported data, and information obtained affected by bias or socially-desirable answers.

† *STATA = Statistics software;* ‡ *SPSS = Statistical Package for the Social Sciences*

Table 12: Data abstraction for papers measuring HPV vaccination uptake

Author (year)	Country	Population, sample size (N), sampling method	Data collection, (year), method	Socioeconomic variables measured (n= number of groups within each variable)	Measure of uptake of preventative strategy	Data analysis, statistical significance	Limitations
Hansen, et al. (2015)	Norway	Norwegian adolescent girls and their parents N=70,870 All available candidates used.	Norwegian National Registry, Norwegian Immunisation Registry (2013) Registry data	Maternal education (5), total income (5), occupation status (4).	HPV vaccination initiation.	Logistic regression. Uses STATA MP version 13.1 Not stated	Analysis used does not address causal relationships or identify individual barriers to HPV vaccine uptake. Some variables included in the multivariable models are correlated, which could introduce over adjustment bias and affect model precision. Possible not adjust for all salient confounders. Likely to be association between variables in this

							comprehensive dataset not fully addressed in the models.
Laz et al. (2013)	United States	Non-institutionalised American women aged 18-26 years N= 1892 Stratified multistage cluster sampling.	National Health Interview Survey, 2010, Questionnaire	Education (3) Income (3)	HPV vaccination initiation	Logistic regression. Uses STATA 10. Statistically significant at $p<0.05$	NHIS data may be subjected to recall bias as they are self-reported. Data not confirmed by provider immunisation records. Could not evaluate if the 3 doses were completed in recommended time frame. Unable to infer causality due

							to cross-sectional design.
Pruitt and Schootman (2010)	United States	American adolescent girls aged 13-17, and their parents N= 1,709 Random sampling and population-based weighting	Behavioural Risk Factor Surveillance System, (2008). (2000) U.S. Census Uses telephone interview.	Maternal education, (3), household total annual income (3).	Receipt of HPV vaccine.	Logistic regression. Uses MLwiN version 2.11. Statistically significant at $p<0.05$.	No data on the validity of the BRFSS HPV measure. Not all respondents were the child's parent so may have had less accurate recall. Only 6 states used so not generalizable to whole of US.

Schulein, et al. (2016)	Germany	German households including at least one girl aged 9-17 N= 4,747 Random sampling, underrepresented groups were purposively recruited for.	Healthcare Access Panel, 2007 Questionnaire	Maternal education (3), household income (3)	HPV vaccination uptake.	Logistic regression. STATA version 8.1 and SAS 9.13. Statistically significant at $p<0.05$	Response rate was relatively low, potential selection bias. Self-reported data, difficulty understanding questions. Information why girls were not vaccinated not explored. Only assessment of mother's SES not fathers.
Tiro, et al. (2012)	United States	Californian adolescent girls aged 12-17 and their mothers N= 3615 Random sampling	California Health Interview Survey, 2007 Telephone survey	Maternal educational attainment (4) household income (4) as a % of federal poverty level.	HPV vaccine initiation.	Chi squared test. Logistic regression. Uses Sudaan version 10.0.1. Statistically significance at $p\leq0.05$.	Low response rate. Data were collected early after licensure of HPV vaccine and a few months after publication of the official recommendations, therefore lower initiation rate are to be expected.

							Access may be limited due to providers' decisions to purchase and stock vaccine. Data was subject to self-report bias. Those without access to landline not represented.
Wei, et al. (2013) **United States**	United States	American women aged 18-26 years N= 1867 Stratified multistage cluster sampling.	National Health Interview Survey, 2010, Questionnaire	Maternal education (2) income (2), and occupation (2)	Ever received HPV vaccine.	Logistic regression. Uses SAS version 9.3. Statistically significance at $p<0.05$	Cross-sectional design precludes causal inference. Self-reported data subject to recall bias. Non-inclusion of households without a landline.

† *STATA = Statistics Software;* ‡ *MLwiN = Centre for Multilevel Modelling;* § *SAS = Statistical Analysis System*

Table 13: Data from studies measuring education and screening and vaccination

	Author (year)	Response rate %	Total sample of eligible women	Outcome (%) (1dp)	N	Variables	N in variable of total sample (%)	N of uptake in variable (%)	OR	CI	p-value
Cervical screening	Becerra-Culqui et al. (2018)	N/A	38,257	Screened (54) Not screened (46)	20,645 17,612	0-50% 51-75% 76-100% (percentage of adults per census block group with greater than high school education)	2173 (5.7) 11,595 (30.03) 24,489 (64.0)	4911 (23.8) 10752 (52.1) 4982 (24.1)	1.00 1.04 1.06	Reference (0.98-1.11) (0.99-1.12)	0.088
	Carrasco-Garrido et al. (2013)	99.2	4040	Screened (65.6) Not screened (34.4)	1787 2253	Primary Secondary University	1193 864 658	719 (60.28) 589 (68.15) 471 (71.56)	1 1.62 2.03	Reference **1.32-1.99** **1.60-2.58**	**<0.05**
	Marlow et al. (2008)	53.4	994	Screened (89) Not screened (11)	866 110	No qualifications At least minimum qualifications	209 (21.1) 779 (78.9)	175 (83.5) 703 (90.2)	1.00 1.66	Reference **1.07-2.56**	**0.023**
	Ricardo-Rodrigues et al. (2014)	61.06	7022	Screening (70.2) Not screened (29.8)	4929 2093	Primary Secondary University	1033 (14.7) 4486 (63.9) 1503 (21.4)	523 (50.6) 3149 (70.2) 1232 (82.0)	1 1.79 2.59	Reference **1.46-2.18** **1.97-3.40**	**<0.05**

	Author (year)	Response rate %	Total sample of eligible women	Outcome (%) (1dp)	N	Variables	N in variable of total sample (%)	N of uptake in variable (%)	OR	CI	p-value
HPV vaccination	Hansen et al. (2015)	N/A	69,306	Initiated (74.6)	67768	Primary/none	1459	1215 (83.3)	1.35	**1.10-1.65**	**<0.05**
						Lower secondary	20383	15,878 (77.9)	0.96	0.90-1.02	
						Upper secondary	44812	35,267 (78.7)	1.00	Reference	
				Not initiated (25.4)	23074	Undergraduate	38418	30,043 (78.2)	0.97	0.92-1.02	
						Postgraduate	8535	6538 (76.6)	0.89	**0.82-0.96**	
	Laz et al. (2013)	94.1	1892	Initiated (12.7)	225	Less than high school	184	6.3			**<0.001**
				Not initiated (87.3)	1667	High school graduate	417	8.4 14.7			
						Some college/college degree	1289				
	Pruitt and Schootman, (2010)		1709	Initiated (34.4)	588	≤High school	550 (32.3)		0.75	0.55-1.00	**0.009**
						Some college	414 (24.2)		1.17	0.88-1.56	
				Not initiated (65.6)	1121	College	522 (30.5)		1	Reference	
	Schulein et al. (2016)	40.2	1906	Initiated (17.4)	332	Basic education	461/ 24.2		1	Reference	**<0.05**
						Medium education	975 /51.2		1.5	**1.1-2.1**	
				Not initiated (82.6)	1574	High education	407/ 21.4		1.5	1.0-2.3	

Author (year)	Response rate %	Total sample of eligible women	Outcome (%) (1dp)	N	Variables	N in variable of total sample (%)	N of uptake in variable (%)	OR	CI	p-value
Tiro et al. (2012)		3615	Initiated (19.4)	749	<12 years	496 (25.4)	82 (16.5)	0.79	0.49-1.28	**0.005**
					High school	759 (23.5)	124 (16.4)	0.63	**0.46-0.87**	
			Not initiated (80.6)	2866	Some college	948 (21.5)	183 (19.3)	0.70	**0.50-0.99**	
					College graduate	1412 (29.5)	342 (24.2)	1.00	Reference	
Wei et al. (2013)		1867	Initiated (21.9)	408	Not high school graduate	291 (15.6)		0.68	**0.48-0.97**	**0.0309**
			Not initiated (78.1)	1459	High school graduate	1576 (84.4)		1.00	Reference	

† Blank spaces indicate data not reported or insufficient data to estimate figures

Table 14: Data from studies measuring income and cervical screening and vaccination

	Author (year)	Response rate	Total sample of eligible women	Outcome (%)	N	Variables	N in variable (%)	N/ % of uptake	OR	CI	p-value
Cervical screening	Becerra-Culqui et al. (2018)	N/A	38,257	Screened (54) Not screened (46)	20,645 17,612	≤45,000 45,001-80,000 >80,000	9425 (24.6) 19893 (52.0) 8939 (23.4)	4911 (23.8) 10,752 (52.1) 4982 (24.1)	1.00 1.03 1.07	Reference (1.00-1.07) (1.03-1.11)	**<0.001**
	Carrasco-Garrido et al. (2013)	99.2%	4040	Screened (65.57) Not screened (34.43)	1787 2253						
	Marlow et al. (2008)	53.4%	994	Screened (89) Not screened (11)	866 110	Tertile 1 (low) (24.6%) Tertile 2 (29.9%) Tertile 3 (high) (32.1%)	244 (24.6) 297 (29.9) 319 (32.1)	218 (89.4) 273 (91.8) 282 (88.3)	1.00 1.34 0.91	Reference 0.77-2.33 0.54-1.54	0.351
	Ricardo-Rodriges et al. (2014)	61.06%	7022	Screened (70.2) Not screened (29.8)	4929 2093						

HPV vaccine

Author (year)	Response rate	Total sample of eligible women	Outcome (%)	N	Variables	N in variable (%)	N/ % of uptake	OR	CI	p-value
Hansen et al. (2015)	N/A	69,306	Initiated (74.6) Not initiated (25.4%)	67768 23074	<200,000 200,000-349,999 350,000-499,999 500,000-699,999 ≥700,000		9591 (70.3) 29012 (77.2) 33790 (80.1) 12654 (81.2) 4820 (82.0)	0.59 0.74 1.00 1.07 1.13	**0.55-0.63** **0.80-0.89** Reference 1.00-1.15 **1.02-1.25**	
Laz et al. (2013)	94.1	1892	Initiated (12.7) Not initiated (87.3)	225 1667	≥200% FPL 100% to <200% FPL <100% FPL	688 (36.0) 399 (21.0) 644 (34.0)	(14.6) (11.1) (11.0)	1.00 0.77 0.40	**Reference** **0.43-1.40** **0.21-0.73**	0.078
Pruitt and Schootman, (2010)		1709	Initiated (34.4) Not initiated (65.6)	588 1121	≥$50,000 25-49,999 ≤24,999	788 (46.1) 308 (18) 299 (17.5)		1.00 0.89 1.53	Reference 0.65-1.23 **1.06-2.21**	**0.002**
Schulein et al. (2016)	40.2%	1906	Initiated (17.4) Not initiated (82.6)	332 1574	High ≥3000€ Medium 1500€ to 2999€ Low <1500€	455 1024 402	(21.2) (53.7) (21.2)	1.3 1.1 1.00	0.9-2.0 0.8-1.6 Reference	>0.05
Tiro et al. (2012)		3615	Initiated (19.4) Not initiated (80.6)	749 2866	0-99% FPL 100-199% FPL 200-299%FPL	504 (18.2) 613 (19.7) 492 (14.5)	83 (16.5) 80 (13.0) 100 (20.4)	0.87 0.60 1.00	0.55-1.40 **0.38-0.96** 0.68-1.48	**0.0042**

Author (year)	Response rate	Total sample of eligible women	Outcome (%)	N	Variables	N in variable (%)	N/ % of uptake	OR	CI	p-value
					≥300% FPL	2006 (47.6)	455 (22.7)	1.00	Reference	
Wei et al. (2013)		1867	Initiated (21.9) Not initiated (78.1)	408 1459	Poverty index <200% Poverty index >200%	1027 (55) 840 (45)		0.73 1.00	**0.68-0.78** Reference	**<0.0001**

† Blank spaces indicate data not reported or insufficient data to estimate figures

Table 15: Data from studies measuring occupation and screening and vaccination

	Author (year)	Response rate (%)	Total sample of eligible women	Outcome (%)	N	Variables	N	% uptake	OR	CI	P-value
Cervical screening	Becerra-Culqui et al. (2018)	N/A	38,257	Screened (54) Not screened (46)	20,645 17,612						
	Carrasco-Garrido et al. (2013)	99.2	4040	Screened (65.57) Not screened (34.43)	1787 2253						
	Marlow et al. (2008)	53.4	994	Screened (89) Not screened (11)	866 110						
	Ricardo-Rodriges et al. (2014)	61.06	7022	Screened (70.2) Not screened (29.8)	4929 2093						
HPV	Hansen et al. (2015)	N/A	69,306	Initiated (74.6) Not initiated (25.4%)	67768 23074	Employed Employed: other Unemployed Outside of workforce		34698 (79.7) 39598 (79.1) 1251 (77.1) 14256 (73.2)	1.04 1.00 0.89 0.72	0.99-1.09 Reference 0.75-1.06 **0.68-0.77**	<0.05

Laz et al. (2013)	94.1	1892	Initiated (12.7) Not initiated (87.3)	225 1667						
Pruitt and Schootman, (2010)		1709	Initiated (34.4) Not initiated (65.6)	588 1121						
Schulein et al. (2016)	40.2%	1906	Initiated (17.4) Not initiated (82.6)	332 1574						
Tiro et al. (2012)		3615	Initiated (19.4) Not initiated (80.6)	749 2866						
Wei et al. (2013)		1867	Initiated (21.9) Not initiated (78.1)	408 1459	Employed Not employed	1090 (58.4) 777 (41.6)		0.88 1.00	0.77-1.00 Reference	0.0550

† Blank spaces indicate data not reported or insufficient data to estimate figures

Table 16: Statistical significance of all socioeconomic variables and uptake of screening or vaccination

		Education	**Income**	**Occupation**
Cervical screening	Becerra-Culqui et al. (2018)	NS	✓✓↑	‘
	Carrasco-Garrido et al., (2013)	✓↑	‘	‘
	Marlow et al., (2008)	✓↑	**NS**	‘
	Ricardo-Rodrigues et al. (2015)	✓↑	‘	‘
HPV vacciantion	Hansen et al., (2015)	✓ ↓	✓↑	**NS**
	Laz et al. (2013)	✓✓↑	**NS**	‘
	Pruitt and Schootman (2010)	✓✓↑	✓✓↓	‘
	Schulein et al., (2016)	✓↑	**NS**	‘
	Tiro et al., (2012)	✓✓↑	✓✓↑	‘
	Wei et al., (2013)	✓↑	✓✓↑	**NS**

NS = not statistically significant p>0.05; ✓= statistically significant, p<0.05; ✓✓= statistically significant, p<0.01 ‘ = not measured

↑=positive association to uptake; ↓= negative association to uptake

Figures:

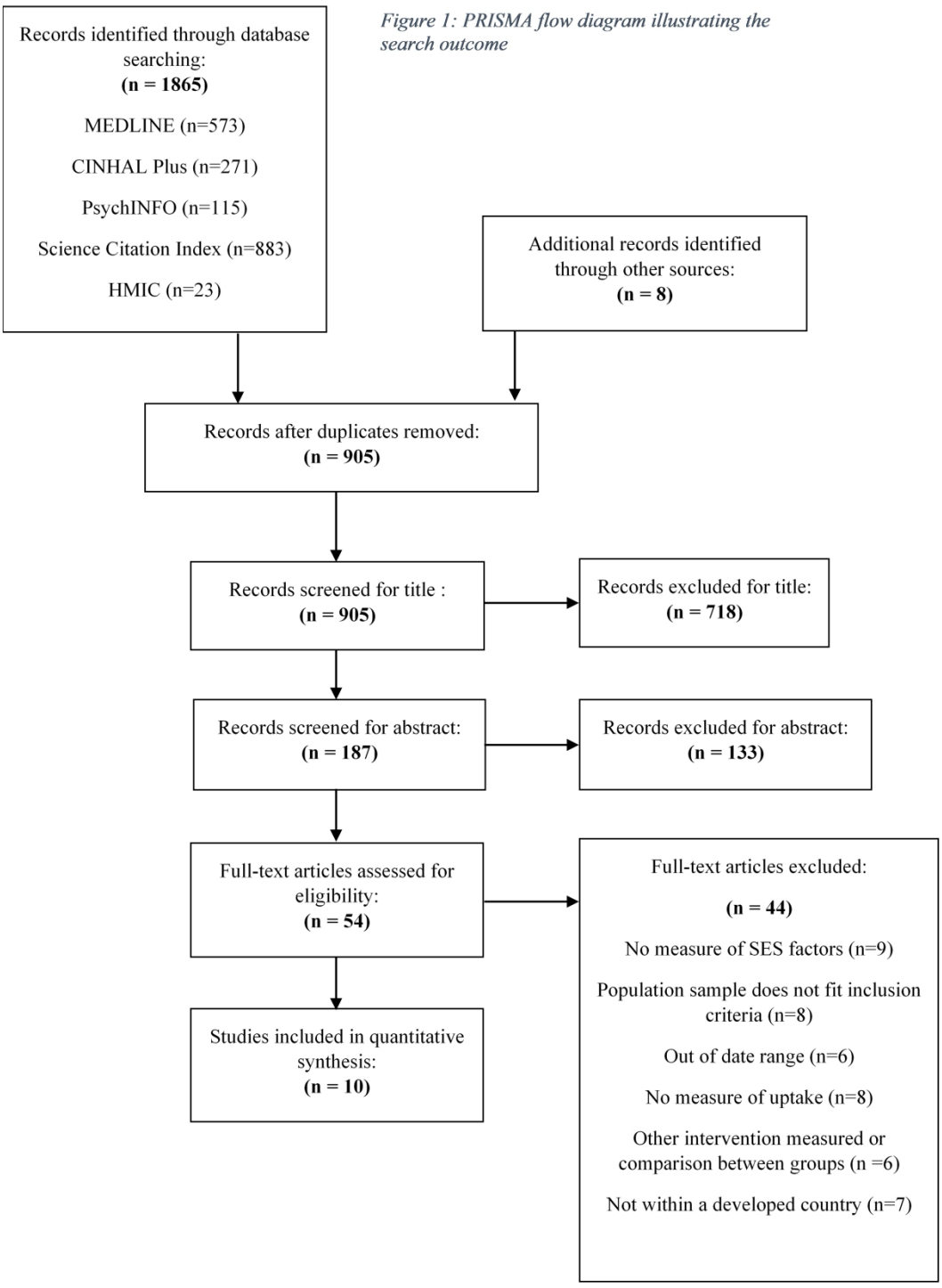

Figure 1: PRISMA flow diagram illustrating the search outcome

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