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Commentary

PhD thesis opposing immunisation: Failure of academic rigour with real-world consequences

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1. Introduction

In 2015 the University of Wollongong, ranked within the top 250 universities in the world, awarded a Doctor of Philosophy (PhD) for a thesis titled "A critical analysis of the Australian government's rationale for its vaccination policy" [1].

The thesis drew national and international interest, and in 2016 Vaccine published a commentary questioning the quality of its academic supervision and examination [2]. The primary supervisor subsequently asserted that the commentary did not cite evidence-based sources, relying on "newspaper articles", and suggested that "it is good scholarly practice in such instances to seek primary documentation, including the views from both sides of contentious cases" [3].

Despite the level of public commentary and its wide dissemination (as of November 2018 it had been downloaded over 21,000 times), to date there is no citable peer-reviewed critical appraisal of the methodological rigour of the work. This is an important gap, as our current research with non-vaccinating parents suggests that some are considering the thesis in their decision-making, and health care providers who may be questioned about it by vaccine-hesitant parents have no such resource to aid their discussions. We therefore set out to identify and appraise the thesis' key claims.

2. Methods

Two authors (KW and MB) read the entire thesis, while the other authors focussed on the sections relevant to their expertise. All arguments were carefully assessed, including reading of key references, to thoroughly understand the author's positions and the evidence brought to support them.

3. Thesis summary

The thesis was executed as a non-systematic descriptive review of the literature with reference to the Australian national vaccine program. The thesis included no primary research, and mostly used the Human Papilloma Virus (HPV) vaccine and the 2009 H1N1 Influenza vaccine as examples to illustrate its claims, which can be summarised under three overarching themes. First, that vaccines are unnecessary, largely based on the assertion that declines in morbidity and mortality due to infectious diseases were well underway prior to vaccine introduction and continued their

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downward trajectory independent of vaccine effects. Second, that vaccines included in the national immunisation program are not based on specific Australian needs but inappropriately justified using data from other countries and/or included because of mandates from international bodies dominated by vaccine manufacturers. Third, that there are important gaps in knowledge for immunisation programs, defined as "Undone Science" – where such questions are not recognised or researched because of political and/or institutional barriers. These themes are described in more detail in Table 1. In the thesis itself, a summary can be found in the abstract (pp iv) and conclusion (pp 306–308) [1].

The quality of the writing and presentation of the thesis is such that many of its arguments could seem plausible to an examiner without specific content knowledge, despite sound academic credentials. Our combined expertise (vaccinology, epidemiology, the history and practise of immunisation policy development globally and in Australia, social science) and as PhD examiners, both gives us detailed knowledge of the sources cited by the thesis, and allows us to identify key deficiencies, summarised below.

3.1. Uncritical analysis due to highly selected referencing

The thesis is presented as "A critical analysis of the Australian government's rationale for its vaccination policy". A critical analysis should consider the merits and faults of an issue and be conducted in a way that is not designed to find only evidence for the writer's pre-determined conclusions. A critical analysis involves judgements based on a set of clearly stated methods and, from a Science Technology and Society perspective, how the writer's position affects those methods.

A systematic literature review would be expected when a thesis explicitly aims to critically analyse a public health intervention with a literature as broad as Australian government vaccination policy. Systematic reviews provide transparency by reporting of the literature search strategy; the methods used for assessing the quality of included studies; and setting out which studies were excluded and why [4]. This enables an author to show that conclusions are drawn from the highest quality published evidence. This thesis does not include methods for assessing the literature, does

Table 1
Thesis "A critical analysis of the Australian government's rationale for its vaccination policy": Main themes and rebuttals.

Theme in thesis	Theme explanation	Why the thesis is wrong
Vaccines are unnecessary	Claims that reduction in death due to infectious disease is due to changes in environment and lifestyle, not vaccines. • Cites decline in all-cause infant mortality since 1910 (no reference to disease-specific figures) • Argues that the infectious agent alone will not cause disease – cites host and environmental factors and concludes that targeting the infectious agent through vaccination will not stop the disease.	• Overall, infant deaths have been reduced by a number of things, including better hygiene and healthcare. • Vaccines contribute to this reduction of infant deaths [9]. • This thesis fails to include more specific data, such as the reduction of deaths due to vaccine-preventable diseases (instead of all-cause mortality), which clearly show that vaccines do contribute to the overall decline in infant mortality. For example, recent application of sophisticated statistical methods taking into account falls in mortality prior to the introduction of vaccines, have clearly shown that vaccines significantly reduced infant mortality, independent of other health improvements [10].
Australian immunisation programs are not based on Australian needs	Claims that the Australian National Immunisation Program (NIP) is developed according to WHO* directives, not for the Australian context. • Claims that VPDs* did not pose a significant threat to the majority of the population, and that targets were set by WHO • Claims that the decision to use vaccines against diseases was a "universal directive", without risk / benefit analysis for each vaccine in specific countries and populations.	• Australian schedule is set according to best evidence as assessed by ATAGI*, not according to WHO directives • Data used in assessment is Australian where possible, if not data from other comparable populations is used. • Risk/benefit analysis is done for each vaccine included on the Australian schedule, often using population – specific data.
Undone Science	• Claims that vaccines are added to the NIP* based on assumptions not backed up by empirical evidence • Claims the public has been told through mainstream media that high vaccination rates will prevent infectious diseases, but there's no empirical evidence for this • Claims "there are no formal controlled clinical trials of vaccines that compare safety and efficacy of vaccines against the disease or against an inert placebo"(pp186) • Claims that post-vaccination safety surveillance not used by government regulators for short or long term AEFI.* • Claims industry is influencing the research agendas of government and research institutions, leading to research not being carried out as the results would be unwelcome by "powerful groups". • Claims HPV* is not an independent cause of cervical cancer, and that lifestyle factors are important co-factors. • Claims that HPV vaccine has not been proven to prevent cervical cancer.	• There is a wide range of evidence used for various vaccines, including RCTs* which tested the vaccines for biologically sound and ethically and technically feasible end-points. • This thesis bases the claims that the government has not provided evidence for the safety and effectiveness of vaccines on online general information resources, such as the AAS* "The science of immunisation" publication and the FAQ* section of the Australian government's web site. While it is acknowledged that the evidence underpinning vaccine policy decisions is not generally publicly available via search engine, it is accessible grey literature that a PhD student could access if they wanted to. There appears to have been no attempt to access this grey literature from the appropriate agencies and institutions. • Active safety surveillance is in place in a number of sentinel institutions for an increasing number of vaccines. More recently there is the PAEDS* network • The "lifestyle factors" associated with cervical cancer listed in the thesis (such as condom use, multiple partners and sex work) are related to infection transmission. There is ample evidence that HPV viruses are strongly associated with cervical cancer. Much of this evidence was research undertaken by Australian scientists, none of which is cited in the thesis. • Evidence for HPV vaccine's role in cervical cancer prevention available: study says at a population level, HPV vaccine associated with significant reduction in cervical abnormalities [11].

*Abbreviations: AAS = Australian Academy of Science; AEFI = Adverse event following immunisation; ATAGI = Australian Technical Advisory Group on Immunisation; FAQ = Frequently Asked Questions; HPV = Human papilloma virus; PAEDS = Paediatric Active Enhanced Disease Surveillance; RCT = randomised controlled trial; VPD = Vaccine Preventable Disease; WHO = World Health Organisation.

not discuss aspects of identified studies which may contradict one another, or attempt to establish the quality of relevant studies. Rather, the references used are highly selective, only citing a small number of the available epidemiological studies and clinical trial reports, all of which are interpreted to support conclusions which appear pre-determined.

3.2. Flawed arguments

A number of arguments in the thesis are fundamentally flawed because they ignore key data. For example, there is a failure to include or address the majority of HPV vaccine safety and efficacy studies and reviews which contradict the arguments of the thesis. Secondly, the thesis demands ethically or technically impossible endpoints as the only way to prove vaccine effectiveness, thus rendering current evidence insufficient. Examples of these flaws are summarised in Table 2.

3.3. Misleading and broad assertions

The thesis claims that decisions about Australian immunisation programs are not based on appropriate local data on disease

Table 2
Thesis "A critical analysis of the Australian government's rationale for its vaccination policy": Main methodological flaws and illustrative examples.[a]

Methodological Flaw	Illustrative example
Uncritical analysis due to highly selected referencing	Section 9.11 deals with adverse events associated with HPV vaccine, making several claims about safety surveillance being inadequate. This claim is supported by reference to a single 2009 report on post licensure passive safety surveillance of HPV vaccines from the American Vaccine Adverse Events Reporting System (VAERS), two reports on primary studies on HPV vaccine safety and efficacy, and a review article written by authors known to be vaccine-critical who were previous collaborators of the author of the thesis. By contrast, published systematic reviews on HPV vaccine safety contain more than 70 references [12], none of which are included in the thesis, with the exception of the above mentioned VAERS report and two primary studies.
Flawed arguments	EXAMPLE 1: The thesis asserts that vaccines are unnecessary, based on the argument that morbidity and mortality due to infectious diseases declined substantially prior to their introduction. While it is true that all-cause infant mortality declined in the first half of the 20th century (this evidence is put forward in Fig. 3 on pp20 of the thesis), the author fails to move from all-cause mortality to the level of vaccine-specific impacts. All-cause mortality is a coarse measure, and only when a given disease causes a substantial fraction of "all cause" mortality in a specific age group will any vaccine effects be apparent. Nevertheless, there are such examples, none of which are cited in the thesis. In the Netherlands, application of sophisticated statistical methods taking into account falls in mortality prior to vaccine introduction in the 1950s, clearly showed that vaccines significantly reduced infant mortality, independent of other previous improvements in social determinants and healthcare [10]. More recently, in the Gambia, a high-mortality country with a high incidence of pneumonia, conjugate pneumococcal vaccine was shown to reduce all-cause mortality due to its impact on pneumonia and meningitis [13]. EXAMPLE 2: Chapter 9 critiques the Australian HPV vaccination program, asserting insufficient evidence of efficacy and safety from vaccine trials. It is argued that cervical intraepithelial neoplasia was inappropriate as a trial outcome, as relatively few progress to cancer, making the four year follow up period of HPV vaccine clinical trials insufficient to evaluate efficacy and safety. However, reporting of the four initial clinical trials (two Phase II, and two Phase III, including 20 583 women 15–79 years, from the Americas, Europe, and Asia-Pacific) explicitly identifies that it would be neither feasible or ethical to attempt to use cervical cancer as an endpoint, as allowing trial participants to progress to cervical cancer would contravene ethical principles and progression of earlier lesions to cancer is well-documented. Peer-reviewed systematic reviews of the literature, available at the time of writing the thesis, showed conclusively that HPV vaccine significantly reduced high-grade cervical pre-cancer lesions [14], and had an excellent safety profile [15], but these reviews and the literature they discuss are not referred to in the thesis.
Misleading and broad assertions	EXAMPLE 1: Chapter 9 claims that the work of scientists in this field is based purely on financial interests: "It is noteworthy that the claims supporting the hypothesis that a vaccine would be effective against cervical cancer were made by a dominant group of scientists with financial links to the vaccine industry (Bosch et al 1995; Walboomers et al 1999; Munoz et al 2006; Franco 1995)."(pp224).The referenced papers used to support this statement relate to the presence of HPV in cervical cancer specimens. While one of these papers (Munoz et al 2006) does list links with pharmaceutical companies among the declared conflicts of interests for three of the four authors as a footnote, the other listed references provide no support, with Bosch et al 1995 and Walboomers et al 1999 listing funding only from government institutions or charities. It is difficult to see how the conclusion that this "dominant group of scientists" all had financial links to the vaccine industry can then be drawn, based on these papers. EXAMPLE 2: Discussion of current vaccine safety data showing "no evidence of harm", leads to the contention that this lack of evidence may be due to a deliberate, collaborative effort on the part of government, academic institutions and industry to ensure that investigations that may uncover such evidence are not funded. "This is occurring within government regulatory boards for medicines/vaccines because the majority of the funding is being directed towards marketing and fast tracking drugs for approval, as opposed to adequate safety testing, monitoring and regulation," (pp203).There is no vaccine-specific evidence cited, with a case study about toxic waste in a town in the UK presented as the only support for this claim.
Incomplete research	The thesis states that "[T]he Australian Government's vaccination policies have not been supported by evidence from appropriately designed scientific studies. The government has not provided this evidence either on the government website, in the Immunisation Handbook or in the Australian Academy of Science's document published in 2012 titled The Science of Immunisation: Questions and Answers. See Chapter 9. This evidence is critical to the government's claim that 'vaccination is an evidence-based policy' and that 'the benefits of vaccines far outweigh the risks'."(pp209)The thesis fails to present a full account of the technical information used to evaluate vaccines for inclusion on the Australian national schedule, nor does it attempt to seek it out, citing only the "example" of chapter 9 of the thesis, dealing specifically with HPV vaccine. While the Australian Immunisation Handbook provides a summary resource intended for immunisation clinicians, and the Academy of Science booklet is an objective resource explaining the technicalities of immunisation aimed at informing members of the public, neither document is sufficient to qualify as an evidence review for a PhD thesis, nor are they intended as a complete record of all the evidence examined by Australian immunisation policy makers, as the author appears to assume. There was no primary research such as interviews with appointed ATAGI members undertaken to support the author's assumption. Had such research been undertaken it would have become evident that ATAGI use a far more comprehensive body of research than can be presented in summary documents such as these, and that data is not always publicly available on government web sites.

[a] Note the examples given here are intended only to illustrate the methodological flaws. Quantifying and enumerating the number of flaws in this thesis was not possible within the word limit of a journal article.

burden and living conditions, asserting that "*directives for Australia's public health policies are provided by the WHO/GAVI alliance that includes partnerships with pharmaceutical companies*"(pp308). This is misleading – while GAVI is an alliance and does include vaccine manufacturer representation, it does not dictate WHO policy and although Australia takes note of WHO recommendations, development of Australian vaccine policy and programs is based on local epidemiology and health systems [5].

The thesis uses the concept of Undone Science to claim that the scientific evidence upon which the Australian national immunisation program is based is insufficient. It defines Undone Science as "*the research that is not conducted because institutional barriers are constructed in the political process to prevent it from being done (Hess 2007, p22)*" (pp195). It asserts that there is strong structural bias around which research is funded, driven by conflicts of interest in government and academic institutions, lack of community representation on advisory boards and financial control over peer review of scientific knowledge (pp197). While the concept of Undone Science has some validity, broad assertions, such as "*Research is increasingly driven by commercial agendas and data secrecy*" (pp199) make it hard to tease out fair criticism from mere impressions.

3.4. Incomplete research

The thesis fails to present a full account of the technical information used to evaluate vaccines for inclusion on the Australian national schedule, nor does it present evidence of an attempt to seek it out, relying on the "example" of HPV vaccine in chapter 9 (see Table 2). It appears to assume that all of the information used to assess a vaccine for inclusion on the Australian schedule is presented on government web sites, in the Australian Immunisation Handbook (a summary resource for clinicians) and a booklet produced by the Academy of Science called "The Science of Immunisation: Questions and Answers" (pp 209). Contrary to this approach, a PhD student undertaking a comprehensive review of Australia's immunisation policy process might start from this point, but would be expected to enrich it by carrying out primary research, such as interviews with members appointed to the Australian Technical Advisory Group on Immunisation (ATAGI), or with scientists who collate and analyse the data to inform ATAGI's decision-making. More detailed enquiry would have identified that National Immunisation Technical Advisory Groups such as ATAGI use a far more comprehensive body of research than can be presented in summary documents, and may not be publicly available on government web sites in its entirety [5,6].

4. Concluding remarks

It might be argued that a thesis on immunisation policy conferred through a Faculty of Law, Humanities and the Arts is not expected to present a detailed and systematic literature review or undertake primary research. We argue that a thesis which explicitly sets out to examine "*Government vaccination policies, including an assessment of the underpinning scientific evidence and the stakeholders who have influence in the decision-making process*" (pp2), irrespective of the faculty or discipline in which it is conducted, should use methods for identifying and assessing scientific evidence of comparable rigour to those used by the academic and scientific bodies which inform policy makers.

This thesis is notable for its lack of evidence of systematic literature review. Despite its extensive claims, there is no primary research, but there is abundant evidence of strong bias in selecting the literature cited and sometimes outright misrepresentation of facts. We agree that critique of immunisation policy is a valid academic exercise that goes beyond technical knowledge [7], but equally it cannot be based on incomplete, flawed technical assertions.

The thesis legitimately highlights the importance of transparency and accessibility in the processes by which vaccines are assessed for inclusion on any national immunisation schedule. It also raises the importance of perceptions about conflicts of interest among contributors to immunisation policy development, and the need for open conversation about policy decisions among all immunisation stakeholders, including the public. These considerations are important for countries seeking to improve established National Immunisation Technical Advisory Groups (NITAGs), as noted by the Supporting Independent Vaccine Advisory Committee (SIVAC) initiative. Areas of public health importance such as immunisation are legitimate topics for scrutiny. It is important to question long-embedded policies and practices, however such scrutiny must be rigorous, disciplined, and draw on the full range of appropriate expertise.

Almost three years after the event, the award of PhD by a reputable University has validated the thesis' claims and allowed the author to add weight to her subsequent prolific writings, including open letters to politicians, and seminars to parents, with consequences on a national and international scale. Tangible evidence of real-world consequences come from two sources. First, two of us (KW and JL), in our research with non-vaccinating Australian parents, find some who state that material in this PhD and its endorsement by a recognised university supports their decision not to vaccinate their children. Second, the author of the thesis has put herself forward as an expert witness in legal proceedings where parents are in dispute over the need for their children's immunisation by positioning her status as a PhD graduate to assert expert status [8].

Those looking for balanced information about immunisation deserve a balanced critique of this thesis to aid them in their decision-making. We believe that our critique serves as an accessible, objective and fair appraisal of the thesis, allowing valid assessment of the quality of the information it presents and the credentials of its author, within the limitations and framework of a journal article.

Author contributions

All Authors contributed to the conception of the work, the appraisal of the thesis and development of the manuscript and have approved the final version.

Conflict of interest

The authors declared that there is no conflict of interest.

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