



CHAPTER 1

Vaccination: Facts, Relevant Concepts, and Ethical Challenges

Abstract This first chapter introduces some ethically relevant concepts that illustrate why we need an “ethics of vaccination”, such as “herd immunity”, “public good”, and “vaccine refusal”. It argues that the choice whether to vaccinate oneself or one’s children is by its own nature an “ethical” choice: it requires individuals to act not only or even not primarily to promote their self-interest but also or even primarily to contribute to an important public good like herd immunity. Besides, since herd immunity is an important public good, ethical questions arise also at the level of state action with regard to the obligations to implement vaccination policies, if necessary coercive ones, that allow to realize herd immunity.

Keywords Vaccination • Herd immunity • Public good • Vaccine refusal • Vaccine delay • Vaccine hesitancy

WHY WE NEED AN ETHICS OF VACCINATION

During the 2017–18 flu season, the spotlights of several major Italian newspapers convened on a high school in the Piedmont region. The students as well as all their teachers had decided to get vaccinated en masse against the flu. One might wonder why the newspapers showed interest in such a seemingly insignificant event; after all, many people choose to be vaccinated against the flu every year. What made this particular story

noteworthy, however, was the reason why the class and the teachers decided to be collectively vaccinated: namely, to protect one of their schoolmates. Some students said they were scared of the needle and of the possible side effects of the vaccine and that they would not have chosen to be vaccinated merely out of their personal desire to be protected from the flu. But one of their schoolmates—Simone—was undergoing cancer therapies and was immunosuppressed at the time, which meant that his immune system was temporarily weakened. Whereas to most healthy people the flu tends to be little more than an uncomfortable inconvenience with few complications, to someone who is immunosuppressed, it is far more disabling and can be life-threatening to a much higher degree. Simone, more than his schoolmates, needed particular protection from the flu.

There are two ways in which an individual can enjoy a relatively high degree of protection from an infectious disease like the flu: one is by being vaccinated and the other is by not being exposed to infected individuals. Unfortunately, according to newspaper reports, Simone could not be vaccinated against the flu because of his weak immune system. I should specify that some details of this story are a bit unclear; in particular, it is not entirely clear whether and why Simone could not be vaccinated: the flu vaccine, unlike some other vaccines that contain weakened forms of the target germ (so-called live attenuated vaccines, or LAVs), is inactivated, that is, it does not contain a live virus. LAVs can be dangerous for immunosuppressed individuals because even the weakened form of a virus could be too strong for their immune system. However, inactivated vaccines are not medically contraindicated for immunosuppressed patients—actually, the inactivated flu vaccine for the immunosuppressed is highly recommended by the medical and scientific community (see, e.g., OVG 2018), considering how dangerous it can be for an immunosuppressed patient to catch the flu. So there seemed to be no medical reason for not vaccinating Simone. In any case, even if Simone could have been—and even if he in fact was—vaccinated, the flu vaccine is less likely to be effective in immunosuppressed individuals. Hence, the only way for Simone to be able to attend school and at the same time remain protected as much as possible against the flu and against its life-threatening complications was to have all his schoolmates and teachers vaccinated as well.

The then Italian Minister of Health, who had been subject to heavy criticisms in the previous months for the new restrictive vaccination policy she had introduced in the country, publicly praised the class' behaviour on

social media and paid a visit to the school to personally thank the students. She rightly wanted to give visibility to a behaviour which, she suggested, should serve as a model for others to follow. Many, including all the newspapers that reported the news, had the same reaction as the Italian Minister of Health. In a note on the high school website, the class described their decision to be collectively vaccinated as an “act of solidarity” towards Simone. There is no doubt the class’ decision was motivated by noble sentiments and that, considering that many of them would not otherwise have got vaccinated, it was in fact an act of solidarity.

This nice story is particularly suited to introducing a book on the ethics of vaccination for three reasons. First, it clearly illustrates, on a small-scale scenario, the practical application of a concept with great ethical relevance when applied on a large scale, namely, that of *herd immunity*—a concept I will return to later in this chapter and throughout the book. Second, the story shows why we need to develop an “ethics of vaccination”, as the title of this book suggests: being vaccinated is a decision that not only could benefit the vaccinated individual but also—and indeed more importantly—contributes to protecting other people around us, thus raising the distinctively ethical question of whether and to what extent we should do something that is not only or even primarily in our self-interest (actually, the individual benefit of vaccination will be minimal or even negligible in some cases, as we will see in Chap. 2). Third, the story suggests that protecting vulnerable people through herd immunity is a collective enterprise, that is, something individuals cannot do alone but need to do together. The collective nature of the effort gives rise to a collective action problem and a tension between collective and individual responsibility. Such tension calls for a philosophical inquiry that can yield precise ethical and, ideally, political prescriptions.

The philosophical inquiry around collective and individual responsibilities will be dealt with in Chap. 2. The policy implications, viewed in light of a principle of least restrictive alternative in public health policy, will be the subject of Chaps. 3 and 4. In this first chapter, I will discuss some of the sources of the ethical problems raised by vaccination and some of the ethically relevant facts about vaccination, clarifying the exact scope of the present discussion and what important ethical issues will be left out.

This book will be successful if, at its conclusion, it will have convinced the reader that in a world where people simply behave in a minimally ethical way—not heroically, only decently—a case like that of the Italian high school class should not be seen as particularly praiseworthy. On the

contrary, I hope readers will come to find it quite unnerving that we live in a world where such fulfilments of a basic moral obligation are praised and deemed so special as to be worthy of news coverage. In more specific terms, this book aims to provide a philosophical and ethical framework for conceptualizing and assessing vaccination decisions that supports two theses. First, that being vaccinated is just the fulfilment of a basic moral obligation. Second, that if individuals fail to fulfil this moral obligation, institutions have the moral responsibility to enforce coercive policies to achieve certain public health and social goals.

As I have mentioned above, ethics is, among other things, about whether and under what circumstances we should make choices that are not (only) in our self-interest but also or even primarily in the interest of other people. Unfortunately, the world we currently live in is far from one of moral decency, at least with regard to individual contributions to public health. Widespread lack of morally decent behaviour—that is, behaviour that complies with very basic moral obligations—with regard to vaccination decisions probably explains and perhaps justifies the media attention that the Italian case attracted. Thus, protection of public health through mass vaccination is something that probably requires coercive state interventions. Thus, writing about the ethics of vaccination means not only writing about individual and collective moral obligations but also about the ethical justification for a certain degree of coercion in vaccination policies. The ethical and political discourses are, in fact, not mutually independent; as I will argue in Chap. 2, the individual moral obligation to contribute to herd immunity provides a moral justification for state policies to exert some degree of coercion in order to vaccinate as many people as possible against the most common vaccine-preventable communicable diseases.

I have said above that effective protection of public health *unfortunately* requires some level of state coercion. Obviously, in a perfect world, individuals would contribute to the protection of public health and other worthwhile causes through autonomous decisions, rather than through external impositions; if people behaved morally, coercion would not be necessary. As Angus Dawson observed with regard to vaccination policies, if people were convinced that there is an individual moral obligation to be vaccinated and fulfilled this obligation, compulsory vaccination or other forms of coercion would be unnecessary (Dawson 2011, pp. 150–151). The need for a book on the “ethics of vaccination” stems from the awareness that not enough people are convinced that there is such a moral

obligation. Thus, to borrow again Dawson's words, "[r]ather than seeing the justifiability (or not) of compulsion as the central issue in vaccination ethics, we can almost take the fact that this is an issue for public policy as a sign that something has gone wrong with the sense of values in such a population" (Dawson 2011, p. 151).

One might wonder how vaccination could have become such a pressing ethical issue, and why certain policies would even be necessary, given that vaccination is a beneficial medical intervention both for those being vaccinated and for the community at large. Do people not have self-interested reasons for having themselves or their children vaccinated at least against the most common infectious diseases, without having to bring up ethical or other-regarding considerations? Why do people refuse vaccination for themselves or for their children if vaccination is beneficial? These are very reasonable and interesting questions, but they are not the kinds of questions I will primarily aim to answer in this book—although I will try to provide some answers later in this chapter. This book is not primarily about the reasons, the motives, or the sociological explanations for why individuals refuse vaccination for themselves or for their children (about which excellent contributions already exist, such as Largent 2012; Navin 2015), nor is it about what strategies could be effective in *convincing* people that vaccination is the right choice to make. This is a book about what kinds of moral obligations people and institutions have with regard to vaccination, regardless of what psychological, social, or cultural factors prevent them from fulfilling such obligations. It is a book about moral values involved in vaccination decisions, rather than about facts about vaccines and vaccination decisions. But of course, facts and values are closely related in the sense that certain facts about vaccination and vaccination decisions do have ethical relevance, that is, they generate certain moral obligations once we agree upon certain very basic and reasonable ethical principles.

For example, here is a fact about vaccines that matters ethically, in the sense that it generates individual and collective moral obligations: society as well as individuals could experience seriously bad consequences, including death, as a result of vaccine-preventable infectious diseases. In 2017, there has been a fourfold increase of measles cases in Europe, going from slightly more than 5000 cases in 2016 to more than 21,000, and about 40 people died of measles in the same year in the European region (WHO 2018). Keep in mind that we are talking about an area of the world where vaccines are easily accessible and relatively cheap. It is unclear how many

of these people (if any) were unsuccessfully vaccinated (after all, the measles vaccine is “only” 93–97% effective, depending on how many doses are administered) or not vaccinated at all against measles, and if so, how many of them had medical reasons for not being vaccinated. It is very plausible to suppose that the vast majority of these cases could have been prevented through vaccination—either of the victims or of the people around of them, or ideally both; as the European Centre for Disease Prevention and Control reports, “of all measles cases reported during the one-year period 1 December 2016 to 30 November 2017 with known vaccination status, 87% were not vaccinated” (ECDC 2018). Since the vaccine against measles—nowadays usually administered together with the mumps and the rubella vaccine in the so-called MMR vaccine—has been around for about 50 years, all the while proving itself to be very safe and effective, one would think that there are more than a few ethical issues raised by vaccine refusal. If these 40 people had been vaccinated, or if they had been successfully protected by herd immunity as a result of those around them having been vaccinated (in the same way as the Italian high school students got vaccinated to protect Simone), these 40 people would probably not have died—I say “probably” because we cannot exclude cases of vaccine failure and low vaccine responders as a possible genetic trait. Therefore, at least some unvaccinated individuals are *causally* responsible for the deaths of these 40 people. But as I will argue in Chap. 2, any non-vaccinated individual, regardless of whether they directly infected other people or not, fails to fulfil their *moral* responsibility to contribute to the prevention of the illnesses and the deaths that occur for vaccine-preventable infectious diseases. Grounding such moral responsibility will require some ethical and philosophical analysis of the concepts of “individual” and “collective” responsibility, which I will undertake in Chap. 2.

Before moving to a more detailed explanation of what an ethics of vaccination is and why it is necessary, three clarifications are in order.

First, when I talk of vaccination, I am not, of course, referring to any possible vaccine available. Certain diseases are not a threat in many parts of the world, particularly Western countries, and there is no need to be vaccinated against those diseases unless one plans to travel in areas of the world where those diseases exist. Examples include vaccines against yellow fever and cholera. This book is not about vaccination ethics for travellers, which is in any case an important and underexplored issue in public health ethics; rather, it is about the ethics of those vaccinations that are typically recommended or mandated in the vaccination schedules of

Western, developed countries. These include the MMR, influenza, pertussis, “6-in-1” (which contains vaccines against six different infectious diseases, including polio), pneumococcal, and rotavirus vaccines (for a list, see, e.g., NHS 2016). Also, as my analysis of the ethics of vaccination unfolds in the next chapters, it will become clear that my arguments only apply to those vaccines that protect against *communicable* infectious disease and therefore not to vaccines against any infectious disease. For example, the ethical considerations I will make do not apply to the vaccine against tetanus, which is not a communicable disease (although the tetanus vaccine is typically administered through the 6-in-1 vaccine, which also contains vaccines against communicable infectious diseases).

Second, I should clarify that when I talk of vaccination, I will refer both to adult and child vaccination. Typically, vaccination targets children of different ages, and even for a vaccine that is commonly chosen by people of all ages, such as the flu vaccine, there are good reasons for vaccination policies to target children rather than adults, given that children suffer higher influenza incidence rates and are therefore more likely to cause seasonal influenza epidemics (Bamberg et al. 2017). Thus, vaccination choices are often choices that adults make on behalf of their children. But adult vaccination is equally important from the point of view of public health, given that adults contribute to vaccine coverage rate and to spreading infections in the same way as children do. It might be thought that referring to both types of vaccination at the same time creates problems when it comes to discussing ethical obligations with regard to vaccination; for example, it is one thing to say that an individual has an obligation to be vaccinated, and it may be quite another thing to say that an individual has an obligation to vaccinate a child who is not competent, or in any case does not have the authority, to consent. I will address this concern in Chap. 2, when I discuss the ethical obligations with regard to vaccination decisions.

Third, I will not be talking about special obligations of certain particular groups—for example, health workers—with regard to vaccination. The reason is simple: since I will be arguing that *everybody* (with a few exceptions) has a moral obligation to be vaccinated and should be subject to a legal obligation to be vaccinated, talking about “special” obligations of certain subgroups would not add anything substantial. For instance, health workers have a moral obligation and should be subject to a legal obligation to be vaccinated not *qua* health workers but simply *qua* members of communities with the collective responsibility to realize herd immunity.

THE LUXURY OF VACCINE REFUSAL AND DELAY

Although this is meant to be a book about the ethics of vaccination, and not about vaccination facts, it goes without saying that certain facts require some scrutiny if we want to adequately understand the ethical issues they raise. In particular, it is useful to say something about why many people today fail to vaccinate themselves or their children, thus exposing them and others around them to easily preventable infectious diseases or in any case exposing them to infectious diseases for longer than necessary.

Let us start by pointing out that referring to all these people as simply “anti-vaxxers”, as many do and as the media usually call them, can be misleading. The term “anti-vaxxers” might be a useful label to indicate very broadly the group of people who, for *whatever* reason, are against vaccination; but it does not do justice to the complexity of reasons or psychological explanations for why people fail to vaccinate themselves or their children. For example, some people who refuse or delay vaccination do not consider themselves to be *against* vaccines as such (as the term “anti-vaxxers” seems to suggest), but rather in favour of “safer” vaccination programmes, thereby excluding some vaccines from the group of the safe ones. Besides, there are different factors, apart from beliefs about vaccine safety and effectiveness, which explain people’s opposition to vaccination; below, I will review some of these factors.

Following Mark Navin (2015, p. 2), anti-vaxxers who deny the safety of vaccines can be referred to as “vaccine *denialists*”. Not all those who fail to vaccinate are vaccine denialists, though. For one, some of them might fail to vaccinate not because they believe that vaccines are unsafe or ineffective, but because they have moral or religious views that are incompatible with the use of vaccines, or simply because they prefer to free-ride on the protection that a sufficiently high percentage of vaccinated people in the community guarantees through “herd immunity” (a concept to which I will return shortly). Moreover, parents are often “hesitant” about vaccination, rather than outright vaccine denialists. Vaccine “hesitancy” refers to the vaccination attitude of people who do not refuse vaccination in principle and hence are not, strictly speaking, “anti-vaxxers” or vaccine denialists. They simply have concerns about whether vaccines are really safe and/or effective, rather than strong beliefs about safety and effectiveness; or alternatively, they might believe—mistakenly (CDC 2018)—that it can be harmful to administer many vaccines at the same time and thus

tend to delay vaccinations or opt only for certain vaccines at any one time (Dubé et al. 2014a).

Of course—and this is a relevant distinction in order to circumscribe the focus of this book—we also need to distinguish non-vaccination that is due to people’s choices or negligence more generally (including, as we will see, the negligence of giving in to unconscious biases) and non-vaccination that is due to factors beyond people’s control. Sometimes people do not have (easy enough) access to vaccines, particularly in developing countries (Favin et al. 2012), but also in developed ones—especially in those with high rates of immigration. Distance from health facilities, internal population displacements and insecurity, and the fact that many illegal immigrants are afraid of being reported to the police if they visit health facilities (Dubé et al. 2014b) are among the factors that might hinder vaccination uptake in many countries. These circumstances contribute to the spread of infectious diseases as much as, if not more than the sociological, cultural, or psychological factors that influence individuals’ choices not to vaccinate themselves or their children where vaccination is easily accessible.

In fact, difficulties in accessing vaccines account for a significant number of cases of preventable diseases and death worldwide. It has been estimated (Durrheim and Crowcroft 2017) that measles vaccination saved 7.1 million lives worldwide between 2000 and 2015. This looks like a remarkable datum, as it obviously is in many respects. However, this figure pales in comparison with the 114,900 people who died of measles worldwide only in 2014 (Perry et al. 2015): if several million lives were saved where vaccines are easily accessible, it is simply unacceptable for 114,900 people to die in one year of the same easily preventable disease just because many of them have difficulties accessing vaccines—just as it is simply unacceptable, to compare, that malnutrition and starvation still exist in certain parts of the world while there is overabundance and waste of food in others. Although these 114,900 deaths represent a stunning 79% decline in measles-related deaths from the 456,800 fatalities of 2000, they remain an objectively too high death toll for a disease that is vaccine-preventable, especially in light of the fact that, since 2010, progress towards the WHO’s goal of eliminating measles from four WHO regions has significantly slowed down (Perry et al. 2015, p. 623). The vast majority of those 114,900 deaths are not the result of people’s choices, as is likely the case for most if not all of the about 40 deaths of measles in Europe in 2017.

What all this suggests, among other things, is that opposition to vaccines is literally a “first world problem”—not in the trivial everyday sense of the term, of course (quite the opposite!), but in the sense that it is a luxury of people in the first world to be in the position to make the *choice* whether or not to vaccinate oneself or one’s children. Granted, opposition to vaccines exists in other parts of the world, too. But death rates in many parts of the developing world are often attributable to access problems, although these may disguise the issue of opposition to vaccines in those countries; on the contrary, the fact that in the developed world we have limited problems of access to vaccines suggests that some form of opposition to vaccines represents the main problem in these areas. The about 40 people who died of measles in Europe in 2017 were the result of people’s choices, including the choice not to choose regarding vaccination and to accept the status quo (which, in countries where vaccination is not mandatory or compulsory, is non-vaccination). Thus, being a book about the ethics of vaccination *decisions* and the ethics of whether and how people’s decisions ought to be *constrained* through vaccination policies, this might be thought of as a book about an ethics for the privileged. And in fact it is, in the same way as books about the ethics of food propose an ethics for the privileged that are in the position to make choices about which kind of food to consume, for example about whether or not to be vegetarian. A comprehensive ethics of vaccination would ideally include prescriptions about which measures ought to be taken at the international level to address the problem of partial or complete lack of access to vaccines in certain parts of the world and in certain subpopulations within developed countries. This is an important challenge and one that international health agencies—the World Health Organization (WHO) *in primis*—are aware of and are working hard to address. But this book does not have the ambitious purpose of covering all the possible ethical issues raised by vaccination and non-vaccination. Addressing the problem of insufficient access to vaccination requires confronting issues of international politics, including the economic and health aid that developed countries ought to provide to poorer countries, as well as issues about facilitating illegal immigrants’ access to healthcare services—after all, the level of public health in a country also depends crucially on the level of health of its immigrants. These considerations, even if not less important than the ones I will be discussing, are beyond the scope of this book. The “ethics of vaccination” will be understood here as the ethics of

individual vaccination *decisions* and of vaccination policies that might sway or determine such individual decisions.

Although I have said above that the term “anti-vaxxers” is too broad to capture the complexity of the phenomenon of vaccine refusal, it remains a useful label to refer to those privileged individuals who actively *choose* not to vaccinate themselves or their children for *any* reason. Now, it has been observed that the perception of the impact of the anti-vaxxers on low vaccination rates tends to be greater than it actually is (Kahan 2014). Also, Samantha Vanderslott has pointed out that scepticism about vaccines or even outright opposition to vaccines often does not translate into actual vaccine refusal—a mismatch that in her view is an instance of the more general psychological phenomenon known as *attitude-behaviour gap* (Vanderslott 2017a). At a first glance, these two considerations seem to suggest—as indeed Vanderslott (2017b) has suggested—that the anti-vaxxers’ impact on vaccination rates is relatively insignificant. For example, in the US, the median rate of active vaccine refusal in the case of parents of school-age children—that is, refusals by actual anti-vaxxers—is 2% (Seither et al. 2017). Perhaps we should not be too worried about such a small proportion of individuals. If this were true, then an ethics of vaccination decisions or of vaccination policies would not be that important, because enough people would already be convinced that vaccination is the right choice and they would not need to be given further ethical reasons or to be coerced by restrictive vaccination policies. Thus, according to this view, where vaccination rates are not high enough, there probably are other factors—such as difficulties in accessing vaccines—that need to be considered, rather than vaccine denialism or a more general anti-vax sentiment. In this scenario, individual decisions and coercive policies would play a relatively small role in determining vaccination rates.

However, according to Vanderslott, the explanation for the mismatch between widespread anti-vaccine sentiment and not-so-widespread vaccine refusal “varies from social pressure to repercussions for not vaccinating” (Vanderslott 2017b). For example, disagreement between parents about child vaccination typically results in rulings in favour of the pro-vaccination parent; and there are penalties that states impose for non-vaccination which constitute strong disincentives for vaccine refusal (such as preventing school entry to the non-vaccinated, as happens in the US, or withholding certain financial benefits, as happens in Australia). But if this is the account offered to explain the small impact of the anti-vaxxers on vaccination rates, then the explanation is question-begging and raises

precisely the ethical issues that this book aims to address. According to this type of explanation, the low rate of active vaccine refusal (e.g., in the form of applications for non-medical exemptions from vaccine mandates in the US) would be due not to the low number of anti-vaxxers, but to external pressures, including how difficult it is to obtain non-medical exemptions and state coercion. Whether such external pressures and state coercion are legitimate is precisely the question that raises the ethical issues that I want to address in this book, namely, whether there is an ethical obligation to vaccinate oneself or one's children and whether a certain degree of coercion, and what degree of coercion precisely, is ethically acceptable or even ethically required in the implementation of vaccination policies.

One important aspect that Vanderslott's reflection raises is that vaccination attitudes must be distinguished, with respect to their practical implications, from actual vaccination decisions. As already said, someone might be deeply opposed to vaccines for a number of possible reasons, but still decide to vaccinate their children for a number of different reasons—including the desire to avoid heavy penalties. Or someone could in principle be in favour of vaccines, or in any case convinced of their overall beneficial effects at the individual and at the collective level, but still decide not to vaccinate themselves or their children, for example because they think that it is safer or more convenient to free-ride on the herd immunity that other members of the community have realized. Now, what matters ethically—or at least this is the stance I will assume in this book—is primarily vaccination *decisions* and only secondarily vaccination *attitudes*. Ethics provides people with certain types of reasons—such as moral obligations—to make certain decisions rather than others. And moral obligations exist regardless of whether people's attitudes align or not with them. As suggested above, it would be ideal if individuals did vaccinate themselves or their children autonomously, because they were convinced of the benefits of vaccines and aware of the fact that vaccination is a moral obligation. However, ultimately, what matters the most is that individuals *do* vaccinate their children, whether or not they think that it is beneficial or morally required. Because vaccination actions matter more in ethical terms than vaccination attitudes, it is important to develop, alongside an ethics of vaccination decisions, an ethics of vaccination policies. Just as ethics in general is about how we should live and what we ought to do, and therefore about how we ought to make practical decisions, so an ethics of vaccination is ultimately about what individuals, collectives, and institutions ought to do with regard to vaccination decisions—that is, about what

moral obligations different actors must fulfil. Of course, this is not to say that individual dispositions, beliefs, concerns, and fears do not matter. Indeed, they have great value, both intrinsically and instrumentally: intrinsically, because it matters morally how people feel when they make certain choices rather than others, and it is morally preferable that choosing vaccination did not undermine their psychological well-being; and instrumentally, because correct beliefs and a correct attitude towards vaccination make it more likely that individuals will fulfil their moral and legal obligations to vaccinate. However, these considerations are of secondary importance. Once we have established that there are certain moral obligations to fulfil and that certain legal requirements would be ethically justified, then individuals have those moral obligations and ought to abide by those legal requirements regardless of what their beliefs and attitudes are. Surely we (which is to say governments, public health authorities, and people who have the capacity and power to influence public opinion) ought to do whatever we can to make sure that as many people as possible are well-informed and have the right kinds of attitudes towards vaccines, for example, through adequate information campaigns and by promoting trust relationship between the medical and scientific community on one side and the wider population on the other. But ultimately, whether or not these attempts are successful does not affect the strength of moral obligations and the legitimacy of coercive vaccination policies.

It is, however, interesting to survey the factors motivating the sort of attitudes towards vaccinations that ultimately result in a total or partial failure to vaccinate where vaccines are easily available. As we will see in Chap. 3, understanding how these attitudes originate might be useful in order to design effective vaccination policies. The factors that explain failure to vaccinate can be divided into four types: sociological, epistemic, cultural, and psychological.

The first type of factor—the sociological one—is the most problematic to describe, for the simple reason that it is unclear whether it actually is a factor that determines vaccination attitudes at all. In particular, it has proven quite difficult to draw correlations between socio-economic status and vaccination decisions. For example, in 2014, Wang and colleagues published a systematic review about the socio-economic status of parents who applied for non-medical exemptions from school vaccination requirements in the US, where in most states parents can be exempted from the mandate through “conscientious objection” to vaccination (Clarke et al. 2017; Navin and Largent 2017; Giubilini et al. 2017). Two studies showed

that parents requesting non-medical vaccination exemptions in the US tend to be white and college-educated and with a higher income than those who did not seek an exemption; however, two other studies found that parents applying for exemptions are more likely to have lower socio-economic status and that parents with lower household incomes were more likely to oppose compulsory vaccination than those with higher income (Wang et al. 2014).

The same review also suggested that the belief that vaccines harm the child is a common and persistent concern among parents who seek non-medical vaccine exemptions. This is the epistemic explanation for vaccine refusal or delay. As is easy to imagine, some parents are vaccine denialists at least to some degree, in that they are simply doubtful of the efficacy or safety of vaccines (Smith et al. 2011; Harmsen et al. 2013). Many of them believe that the risk of iatrogenic diseases (i.e., diseases caused by excessive attempts to treat or prevent another medical condition) resulting from vaccination is greater than the risks deriving from the disease that vaccination would prevent, and that therefore it is not worth taking it (Salmon et al. 2005; Wang et al. 2014). Others believe that it is sometimes beneficial to catch an infectious disease because the disease would strengthen the immune system and therefore protect the child from future, and perhaps more severe, diseases (Hough-Telford et al. 2016). All these beliefs are false, at least in most circumstances (as we will see in Chap. 2, when vaccination rates are very high, the first type of belief might be correct). Therefore, the problem here concerns how people come to form certain incorrect beliefs about medical fact; in other words, the explanation for the failure to vaccinate is epistemic in nature.

Some parental opposition to vaccines can, however, be explained by what I have called the cultural factor. In this case, the explanation refers to some ethical or religious aspect of the cultural background of people who refuse or delay vaccines. Some people have ethical reasons for opposing vaccines; for example, some have ethical quandaries about using vaccines that contain viruses grown from cell lines derived from aborted foetuses or animals (Salmon et al. 2005). However, it should be noticed that it is likely that the facts about vaccine manufacture that these people have in mind are ethically less significant than they think. For example, the two only human foetal cell lines used to grow viruses for vaccines today are derived from two foetuses aborted therapeutically—that is, not for the purpose of deriving cell lines—in the 1960s. All the other vaccines that require cell lines derive them from animals, and even among these vaccines,

only four are commonly mandated or recommended in standard vaccination schedules, or are anyway normally administered: the hepatitis A, rubella, chickenpox, and zoster vaccines. Meanwhile, other people are opposed to vaccines because they belong to certain religious groups with specific prohibitions. However, it is worth pointing out that it is difficult to correctly attribute vaccine refusal to religious beliefs. For example, while a 2005 survey of parents in the US found that 9% of parents refused vaccination on the basis of religious beliefs (Salmon et al. 2005), a 2014 WHO report found that, according to a survey among immunization managers in different countries, religious beliefs were perceived to be the most common determinant of vaccine hesitancy (WHO 2014). What accounts for this discrepancy between two different interpretations of the role of religious beliefs in vaccine refusal? Part of the explanation might be that religious opposition to vaccines is sometimes misattributed. For example, it has been suggested that one of the reasons why Amish communities in the US have very low vaccination rates is not, as the myth goes—and as I have suggested in a previous publication (Giubilini et al. 2018)—that they have a religious opposition to vaccines, but simply that it is relatively difficult for isolated Amish communities to access vaccination services (Wenger et al. 2011). Besides, even if the phenomenon of vaccine refusal is quite widespread among some Christian religious groups (such as Christian Scientists, Dutch Reformed Church members, or the Amish), it seems that the Catholic social teaching is not incompatible with, and indeed does entail, a moral obligation to vaccinate in order to protect the community against serious harm (Carson and Flood 2017). Therefore, religion might play a more limited role, both psychologically and philosophically, than commonly thought in an explanation of vaccine refusal and vaccine delay.

It could reasonably be argued that a similar problem regarding correct attribution of reasons for vaccine refusal or vaccine delay exists with respect to any of the self-reported reasons just mentioned. How so? The answer has to do with the fourth kind of explanation for vaccine delay or refusal I mentioned above, namely, the psychological explanation. Regardless of what reasons people provide for their opposition to vaccination, much of this opposition turns out to be irrational, at least according to a psychological definition of (practical) “rationality”, that is, as the capacity to make decisions based on conscious reasoning rather than merely on unanalysed intuitions and emotions. According to Joshua Greene’s characterization of rationality, “reasoning, as applied to decision making, involves the

conscious application of decision rules (...). Reasoning frees us from the tyranny of our immediate impulses by allowing us to serve values that are not automatically activated by what's in front of us" (Greene 2013, p. 136). I will accept this psychological definition, whereby a decision is rational if it is based on reasons that the agent is aware of (of course, other, more philosophical notions of "rationality" would not consider this as a sufficient or even a necessary condition for rationality). Now, as it turns out, rationality thus understood is not what many people rely on to make vaccination decisions. Let us analyse the issue of rationality in vaccination decisions in more detail.

If most vaccination decisions were actually based on rationality, it would be difficult to explain why, as Mark Navin has concluded from his analysis of vaccine refusal, many vaccine refusers know more about vaccines than do parents who vaccinate (Navin 2015, p. 10). If vaccination decisions were based on knowledge of facts about vaccination, including their safety and effectiveness, rational people would opt for vaccination in spite of the small risks of iatrogenic diseases involved, at least when vaccination coverage rates are low and protection from infectious disease hence cannot be guaranteed through herd immunity. But the fact that many vaccine refusers or vaccine-hesitant people have fairly good knowledge of vaccines suggests that, in many cases, decisions not to vaccinate are not based on reason alone, at least as defined by Greene.

And in fact, psychological research seems to support the thesis that many decisions to refuse or delay vaccination are of an irrational nature. For example, while public health authorities often encourage doctors to discuss risks and benefits of vaccination with parents who are opposed to vaccines (Omer et al. 2009), some evidence seems to suggest that many sceptical parents are unlikely to be swayed by risk-benefit analysis of vaccination (Meszaros et al. 1996). Further psychological research has suggested that vaccination decisions are often likely to be the result of biased judgements, rather than of cool reasoning. A bias can be defined as an unanalysed prejudice that leads to systematic errors or deviations from rationality standards in judgements or decisions. In particular, psychological research has brought up "omission bias" and "naturalness bias" to explain much of the opposition to vaccines. Omission bias can be defined as "the tendency to see a negative outcome resulting from inaction (omission) as more favourable than the same negative outcome resulting from action (commission)" (Di Bonaventura and Chapman 2008, p. 2). In the case of vaccination, omission bias is the tendency to see the possible negative outcomes resulting from infectious diseases, and hence from non-vaccination, as more favourable than the negative outcomes resulting from

vaccination. The naturalness bias is “the tendency to prefer natural products or substances even when they are identical to or worse than synthetic alternatives” (Di Bonaventura and Chapman 2008, p. 2). Now, strictly speaking, it is not correct to consider the vaccines routinely offered or mandated as “synthetic”, because these vaccines contain the very same pathogens that cause diseases and because authentically “synthetic” vaccines obtained using a variety of molecular antigens only constitute a subgroup of vaccines that have more recently been developed (Jones 2015). However, we can still say that, in the case of vaccination, naturalness bias manifests itself in the tendency to see natural remedies or even the natural germs themselves (i.e., germs that naturally infect people) as preferable to vaccines, which consist of the same germs (either live or inactivated) but are produced in “synthetic” laboratory conditions. DiBonaventura and Chapman showed that naturalness bias, as revealed by people’s preference for a herbal drug over a chemically identical synthetic drug, was negatively correlated with participants’ intention to obtain a flu vaccine. In the same way, they showed that omission bias, as revealed by parents’ refusal of vaccines carrying a risk of iatrogenic disease lower than the risks entailed by the possibility of catching the disease without vaccination, was negatively correlated with the intention to vaccinate. One study found that “[t]he association between non-vaccination and omission bias is not peculiar to those with more or less education, although the more educated respondents (...) were more likely to resist vaccination” (Asch et al. 1994, p. 121). While it is true that correlation (between biases and vaccination decisions) is not the same as causation, it is reasonable to suppose that these biases do play a role in determining vaccination decisions and that therefore such decisions are not rational or based on knowledge about vaccines. This seems to be confirmed, at least with regard to omission bias, by another study that analysed omission bias in vaccination decisions by observing how it affects parents’ sense of responsibility for the health outcomes of their children. The study (Ritov and Baron 1990) found that many parents would feel more responsible for the hypothetical death of their child if the death were caused by a vaccine they decided to administer to the child than if the child’s death were caused by the very disease against which they decided not to vaccinate. The fact that the same outcome, resulting in both cases from their decision, is associated with a different sense of responsibility depending on whether it is the result of an action or an omission seems to suggest that there is an omission bias at play here. In the qualitative part of the study, a subject said: “I feel that if I vaccinated

my kid and he died I would be more responsible for his death than if I hadn't vaccinated him and he died—sounds strange, I know. So I would not be willing to take as high a risk with the vaccine as I would with the flu” (Ritov and Baron 1990, p. 275).

It is not unreasonable, then, to suppose that at least part of the opposition to vaccines is explained not so much by the standard reasons offered by people in surveys about motivations for vaccine refusal or vaccine delay, but by some irrational or biased stance. In other words, concerns about vaccines' safety or effectiveness are likely to be post hoc rationalizations of irrational stances. Granted, it might be argued that a preference for bad outcomes resulting from omission over bad outcomes resulting from action or a preference for the natural over the non-natural (whatever this is taken to mean) do not constitute “biases” as I have defined the concept here. After all, these preferences might be the result of careful ethical reflection rather than of an unanalysed prejudice—which of course does not rule out that the reflection be mistaken; the point is simply that a decision can be irrational and/or unethical without necessarily being the product of some bias. I do not know in what proportion people who refuse vaccination are biased and in what proportion instead they have a reasoned preference for omission over action and for the natural over the unnatural. What I want to highlight is simply that these types of preferences based on allegedly morally relevant distinctions (act/omission; natural/unnatural) are typically not mentioned when people are surveyed about the reasons why they refuse vaccination. This fact seems to suggest, at the very least, that the reasons people offer for their refusal of vaccines do not fully explain their choices and that therefore there is at least an irrational element in such choices not to vaccinate themselves or their children.

HERD IMMUNITY AS A PUBLIC GOOD

According to many advocates of coercive vaccination policies, the ultimate goal of such policies should be herd immunity. More precisely, consistently with a principle of “least restrictive alternative”, these authors think that states should implement the least coercive policy that is necessary to achieve herd immunity, even if the least restrictive policy entails some level of coercion (e.g., Flanigan 2014; Navin 2015; Pierik 2016). In Chap. 3, I will examine what the principle of “least restrictive alternative” implies with regard to which vaccination policies should be prioritized in the

attempt to realize herd immunity from any infectious disease. In Chap. 4, I will question the assumption that vaccination policies should aim *only* at herd immunity. But in order to properly assess the importance of herd immunity and how herd immunity gives people the opportunity to free-ride, thus creating a collective action problem that needs to be regulated through specific—and, if necessary, coercive—policies, it is useful to take a closer look at what herd immunity is and analyse its nature of public good.

Herd immunity is, quite simply, a form of indirect protection from infectious disease. Herd immunity is obtained when a large enough portion of the population is vaccinated, preventing germs from circulating and thereby rendering an infectious disease very unlikely to spread (Fine et al. 2011; Kim et al. 2011). The vaccination coverage rate required for herd immunity varies for different diseases; for example, for measles it ranges between 90% and 95% and for polio between 80% and 85%.

Interestingly, a survey (Sobo 2016) conducted among parents in some US states found that although most parents (70%) were familiar with the notion of “herd immunity”, most of these parents did not think it was a reliable measure of safety from infectious disease. In a sense, there is an element of truth in this belief: herd immunity does not offer the same level of individual protection as individual vaccination does and hence is not an equivalent alternative to vaccination. However, herd immunity remains the best form of protection for certain individuals who cannot be vaccinated for medical reasons; for example, the case of the Italian high school class vaccinated against the flu to protect Simone is a case of herd immunity realized on a small scale in order to protect a vulnerable individual.

Now, there are practical problems with relying on herd immunity as a measure for protecting public health and vulnerable individuals. Most notably, the more the rate of international travels intensifies, the less meaningful and useful herd immunity becomes as a preventive measure. With people travelling and moving from one region, state, or continent to the other at an unprecedented rate, it becomes increasingly difficult to identify the relevant community within which herd immunity should be achieved: in one sense, the world has become one big community in a way in which it was not until relatively recently. Simone was protected against the flu only as long as he stayed within his classroom and as long as no out-group unvaccinated individual entered the classroom. If this scenario seems unrealistic when we think of a school class, it is also unrealistic in the large-scale scenario of our globalized world. Ideally, herd immunity would

need to be achieved at the global level and not just within national boundaries. However, since vaccination policies are typically implemented at the national level, as things stand now, the only way to ensure that vulnerable individuals are protected as much as possible in the globalized world is that each nation realizes herd immunity within its jurisdiction.

It is important to understand the concept of “herd immunity” not only from a medical and scientific point of view but also with regard to its social and ethical relevance. In Chap. 2, I will explain how, given certain ethical premises, the existence or prospect of herd immunity grounds an individual moral obligation to be vaccinated or to vaccinate one’s children. For the moment, in order to prepare the ground for such discussion, it will be useful to say something more about the ethical and social significance of herd immunity and what it means for herd immunity to have “ethical” and “social” significance.

In order to do this, we need first to reflect on its nature of collective good and of public good (Dawson 2007). That herd immunity is a collective good means, quite simply, that the cooperation of a sufficiently large number of people is required to realize it (Dawson 2007, pp. 167–168): no individual or small group of individuals can realize herd immunity. That herd immunity is a public good means that it is both *non-excludable* and *non-rivalrous*. These are technical terms borrowed from the field of economics. Simply put, a good is non-excludable if no one can easily be prevented from benefitting from it (it is often possible to prevent individuals from benefitting from public goods, but when this would be difficult or very costly, the good is considered non-excludable); and a good is non-rivalrous if any individual benefitting from it does not diminish the extent to which other individuals benefit as well. A firework show is an example of a public good. However, firework shows are not important public goods because they do not significantly impact on the well-being of those who enjoy them, and certainly they are not necessary in order to fulfil some fundamental right of individuals; therefore, we cannot say that society or institutions have a moral obligation to provide firework shows. Important public goods are instead things like clean air, national defence, and flood defences; these are the public goods that, for the sake of everyone’s interest, a society ought to maintain through a joint effort of its members and/or through institutional interventions. Herd immunity from infectious diseases belongs to this category of important public goods. In Chap. 2, we will see how herd immunity gives rise to collective, individual, and institutional obligations.

Earlier, I said that herd immunity has both social and ethical relevance. It is easy to see in what sense herd immunity has *social* relevance: society as a whole is affected by whether or not herd immunity from any infectious disease exists. A well-functioning society requires a certain level of public health. Herd immunity produces benefits at the societal level because it improves public health and reduces the public costs of health-care as well as the economic losses associated with illnesses. Everybody benefits from living in a society with herd immunity and therefore with a low rate of infections, regardless of whether they are vaccinated. More precisely, there are three ways in which herd immunity benefits individuals and society. First and foremost, herd immunity protects the unvaccinated. Second, and perhaps less obviously, herd immunity protects the vaccinated as well, since no vaccine is 100% effective; for example, for the 2018 flu season, the estimate of vaccine effectiveness against influenza A (H3N2) was only 10% (Paules et al. 2018), and the pertussis vaccine is only 70% effective during the first year and its effectiveness decreases to 30–40% after four years (CDC 2017). Third, everybody benefits from herd immunity because living in a society with herd immunity means that less public resources need to be diverted to treat sick people; for example, in the US, the flu costs annually US\$10.4 billion for hospitalizations and outpatient visits, and the total economic cost associated with annual influenza epidemics, including loss of earning caused by illness, has been estimated to be US\$87.1 billion (Molinari et al. 2007). Preserving or realizing herd immunity is therefore important for society, and there are strong ethical as well as economic reasons for a collective to realize herd immunity.

Meanwhile, the *ethical* relevance of herd immunity is explained by its nature of public good as well as by its being a matter of collective, rather than individual responsibility. I will discuss the former aspect here, and the latter in the next chapter. Like all public goods, herd immunity gives rise to a *free-riding problem*. This problem arises when someone would benefit from a certain good regardless of whether they contribute to the good. In such circumstances, a person does not have any incentive to make their contribution; instead, they have an incentive to “take a free ride”. The free-riding problem, in turn, gives rise to a collective action problem, that is, a problem that arises because too many people do or fail to engage in a certain action: it is rational for anyone not to contribute to a public good, but too many people acting rationally and failing to contribute compromise the very same public good. The problem arises in the case of vaccination precisely because there is no incentive, and indeed it might be irrational (at least in terms of cost-benefit

analysis) for any person to contribute to herd immunity through vaccination when they know herd immunity already exists, since they would be (sufficiently) protected from infectious disease anyway. This mismatch between individual interest and collective interest is precisely where the ethical relevance of herd immunity lies: *if* the preservation or the realization of herd immunity posed any requirement on people at all, it would require (at least some) people to make their contribution to the public good regardless of whether vaccination would be (significantly) beneficial to them or of whether the risk/benefit assessment of vaccination is favourable. Therefore, being vaccinated is often primarily an *ethical* choice: its social importance requires individuals to make a choice for the sake of the public good, rather than exclusively for the sake of their own individual benefit. Besides, because individuals do not have strong enough incentives to contribute to public goods, and because we cannot expect that a large enough number of individuals behave ethically and make their selfless contribution to public goods—free-riding is often simply too tempting—typically the protection or realization of public goods requires institutions to enforce specific policies that, if necessary, coerce individuals into making their contribution. In Chaps. 3 and 4 I will discuss the ethical justifiability of different possible vaccination policies.

Of course, as said above, one might observe here that individuals do stand to benefit from vaccination, because vaccination confers them protection (though not 100% protection) against infectious diseases, and therefore the benefit is primarily individual, and therefore vaccination is rational from the point of view of individual interest; only secondarily, and as a side effect, vaccination contributes to benefitting others. However, there are two considerations to be made here: first, many individuals do not think that they (or their children) would benefit from vaccination, so to them, vaccinating would still be seen as something that goes against their personal interest, and second, as I have mentioned earlier and as we will see better in Chap. 2, vaccination ceases to be individually overall beneficial when vaccination coverage rates are sufficiently high and the small risks of vaccination outweigh the risk of catching the disease and the risks associated with the disease (which oftentimes include the risk of death).

But as mentioned above, the concept of herd immunity is also ethically relevant because realisation or preservation of herd immunity is a matter of collective, rather than individual responsibility: on a large population, no single individual can, by herself, make a significant difference to whether herd immunity exists. How can individuals have an ethical obligation to

make an insignificant contribution? So far, I have only said that *if* individuals have a reason to contribute to herd immunity, this has to be an ethical reason, that is, a reason not based (exclusively) on self-interest. But I have not yet demonstrated that individuals *do* have such a reason or ethical obligation. Actually, at a first glance, there seem to be no good reason or ethical obligations to contribute, regardless of whether one has the selfish desire to free-ride: one more vaccinated individual would not make a significant difference to whether a certain community realizes herd immunity or not. What is the ethical reason for being vaccinated or for vaccinating one's children, then? This is the question I will address in the next chapter.

REFERENCES

- Asch, D. A., Baron, J., Hershey, J. C., Kunreuther, H., Meszaros, J., Ritov, I., & Spranca, M. (1994). Omission Bias and Pertussis Vaccination. *Medical Decision Making: An International Journal of the Society for Medical Decision Making*, 14(2), 118–123.
- Bamberg, B., Douglas, T., Selgelid, M. J., Maslen, H., Giubilini, A., Pollard, A. J., & Savulescu, J. (2017). Influenza Vaccination Strategies Should Target Children. *Public Health Ethics*, 11, 221–234.
- Carson, P. J., & Flood, A. T. (2017). Catholic Social Teaching and the Duty to Vaccinate. *The American Journal of Bioethics: AJOB*, 17(4), 36–43.
- CDC (Centers for Disease Control and Prevention). (2018). *Multiple Vaccines and the Immune System*. Retrieved April 2018, from <https://www.cdc.gov/vaccinesafety/concerns/multiple-vaccines-immunity.html>
- CDC (Centers for Disease Control and Prevention). (2017). Pertussis FAQ. Retrieved April 2018, from <https://www.cdc.gov/pertussis/about/faqs.html>
- Clarke, S., Giubilini, A., & Walker, M. J. (2017). Conscientious Objection to Vaccination. *Bioethics*, 31(3), 155–161.
- Dawson, A. (2007). Herd Protection as a Public Good: Vaccination and Our Obligations to Others. In A. Dawson & M. Verweij (Eds.), *Ethics, Prevention, and Public Health* (pp. 160–178). Oxford: Clarendon Press.
- Dawson, A. (2011). Vaccination Ethics. In A. Dawson (Ed.), *Public Health Ethics. Key Concepts and Issues in Policy and Practice* (pp. 143–153). New York: Cambridge University Press.
- Di Bonaventura, M., & Chapman, G. B. (2008). Do Decision Biases Predict Bad Decisions? Omission Bias, Naturalness Bias, and Influenza Vaccination. *Medical Decision Making*, 28(4), 532–539.

- Dubé, E., Laberge, C., Guay, M., Bramadat, P., Roy, R., Bettinger, J. A. (2014a). Vaccine Hesitancy. *Human Vaccines & Immunotherapeutics* 9(8), 1763–1773.
- Dubé, E., Gagnon, D., Nickels, E., Jeram, S., & Schuster, M. (2014b). Mapping Vaccine Hesitancy—Country-Specific Characteristics of a Global Phenomenon. *Vaccine*, 32(49), 6649–6654.
- Durrheim, D., & Crowcroft, N. (2017). The Price of Delaying Measles Eradication. *The Lancet Public Health*, 2(3), e130–e131.
- ECDC. (2018, January). *Measles in the EU/EEA: Current Outbreaks, Latest Data and Trends*. Retrieved May 2018, from <https://ecdc.europa.eu/en/news-events/measles-eueea-current-outbreaks-latest-data-and-trends-january-2018>
- Favin, M., Steinglass, R., Fields, R., Banerjee, K., & Sawhney, M. (2012). Why Children Are Not Vaccinated: A Review of the Grey Literature. *International Health*, 4(4), 229–238.
- Fine, P., Eames, K., & Heymann, D. (2011). “Herd Immunity”: A Rough Guide. *Clinical Infectious Diseases*, 52(7), 911–916.
- Flanigan, J. (2014). A Defense of Compulsory Vaccination. *HEC Forum*, 26, 5–25.
- Giubilini, A., Douglas, T., & Savulescu, J. (2017). Liberty, Fairness, and the ‘Contribution Model’ for Non-medical Vaccine Exemption Policies: A Reply to Navin and Largent. *Public Health Ethics*, 10(3), 235–240.
- Giubilini, A., Douglas, T., & Savulescu, J. (2018). The Moral Obligation to Be Vaccinated: Utilitarianism, Contractualism, and Collective Easy Rescue. *Medicine, Health Care, and Philosophy*. <https://doi.org/10.1007/s11019-018-9829-y>.
- Greene, J. (2013). *Moral Tribes. Emotion, Reason, and the Gap Between Us and Them*. London: Atlantic Books.
- Harmsen, I. A., Mollema, L., Ruiter, R. A. C., Paulussen, T. G. W., de Melker, H. E., & Kok, G. (2013). Why Parents Refuse Childhood Vaccination: A Qualitative Study Using Online Focus Groups. *BMC Public Health*, 13, 1183.
- Hough-Telford, C., Kimberlin, D. W., Aban, I., Hitchcock, W. P., Almquist, J., Kratz, R., & O’Connor, K. G. (2016). Vaccine Delays, Refusals, and Patient Dismissals: A Survey of Pediatricians. *Pediatrics*, 138(3), 2016–2127.
- Jones, L. (2015). Recent Advances in the Molecular Design of Synthetic Vaccines. *Nature Chemistry*, 7, 952–960.
- Kahan, D. (2014). *Vaccine Risk Perceptions and Ad Hoc Risk Communication: An Empirical Assessment* (CCP Risk Perception Studies Report No. 17, Yale Law & Economics Research Paper # 491). SSRN: <https://ssrn.com/abstract=2386034>
- Kim, T. H., Johnstone, J., & Loeb, M. (2011). Vaccine Herd Effect. *Scandinavian Journal of Infectious Diseases*, 43(9), 683–689.
- Largent, M. (2012). *Vaccine. The Debate in Modern America*. Baltimore: Johns Hopkins University Press.

- Meszaros, J. R., Asch, D. A., Baron, J., Hershey, J. C., Kunreuther, H., & Schwartz-Buzaglo, J. (1996). Cognitive Processes and the Decisions of Some Parents to Forego Pertussis Vaccination for Their Children. *Journal of Clinical Epidemiology*, 49(6), 697–703.
- Molinari, N.-A. M., Ortega-Sanchez, I. R., Messonnier, M. L., Thompson, W. W., Wortley, P. M., Weintraub, E., & Bridges, C. B. (2007). The Annual Impact of Seasonal Influenza in the US: Measuring Disease Burden and Costs. *Vaccine*, 25(27), 5086–5096.
- Navin, M. (2015). *Values and Vaccine Refusal: Hard Questions in Ethics, Epistemology, and Health Care*. New York: Routledge.
- Navin, M., & Largent, M. (2017). Improving Nonmedical Vaccine Exemption Policies: Three Case Studies. *Public Health Ethics*, 10(3), 225–234.
- NHS (National Health Service UK). (2016). *Vaccinations*. Retrieved May 2018, from <https://www.nhs.uk/conditions/vaccinations/>
- Omer, S. B., Salmon, D. A., Orenstein, W. A., deHart, M. P., & Halsey, N. (2009). Vaccine Refusal, Mandatory Immunization, and the Risks of Vaccine-Preventable Diseases. *The New England Journal of Medicine*, 360(19), 1981–1988.
- OVG (Oxford Vaccine Group). (2018). *Inactivated Flu Vaccine*. Retrieved February 26, 2018, from <http://vk.ovg.ox.ac.uk/inactivated-flu-vaccine>
- Paules, C. I., Sullivan, S. G., Subbarao, K., & Fauci, A. S. (2018). Chasing Seasonal Influenza—The Need for a Universal Influenza Vaccine. *The New England Journal of Medicine*, 378(1), 7–9.
- Perry, R. T., Murray, J. S., Gacic-Dobo, M., Dabbagh, A., Mulders, M. N., Strebel, P. M., et al. (2015). Progress Toward Regional Measles Elimination—Worldwide, 2000–2014. *MMWR. Morbidity and Mortality Weekly Report*, 64(44), 1246–1251.
- Pierik, R. (2016). Mandatory Vaccination: An Unqualified Defense. *Journal of Applied Philosophy*. <https://doi.org/10.1111/japp.12215>.
- Ritov, I., & Baron, J. (1990). Reluctance to Vaccinate. Omission Bias and Ambiguity. *Journal of Behavioural Decision Making*, 3, 263–277.
- Salmon, D. A., Moulton, L. H., Omer, S. B., DeHart, M. P., Stokley, S., & Halsey, N. A. (2005). Factors Associated with Refusal of Childhood Vaccines Among Parents of School-Aged Children: A Case-Control Study. *Archives of Pediatrics & Adolescent Medicine*, 159(5), 470–476.
- Seither, R., Calhoun, K., Street, E. J., Mellerson, J., Knighton, C. L., Tippins, A., & Underwood, J. M. (2017). Vaccination Coverage for Selected Vaccines, Exemption Rates, and Provisional Enrollment Among Children in Kindergarten—United States, 2016–17 School Year. *MMWR. Morbidity and Mortality Weekly Report*, 66(40), 1073–1080.
- Smith, P. J., Humiston, S. G., Marcuse, E. K., Zhao, Z., Dorell, C. G., Howes, C., & Hibbs, B. (2011). Parental Delay or Refusal of Vaccine Doses, Childhood

- Vaccination Coverage at 24 Months of Age, and the Health Belief Model. *Public Health Reports*, 126(Suppl 2), 135–146.
- Sobo, E. (2016). What Is Herd Immunity, and How Does It Relate to Pediatric Vaccination Uptake? US Parent Perspectives. *Social Science and Medicine*, 165, 187–195.
- Vanderslott, S. (2017a, April 24). Despite Scepticism, Europe Has High Vaccination Rates—But It Shouldn't Be Complacent. *The Conversation*. Retrieved March 19, 2018, from <https://theconversation.com/despite-scepticism-europe-has-high-vaccination-rates-but-it-shouldnt-be-complacent-75169>
- Vanderslott, S. (2017b). Anti-vaxxer Effect on Vaccination Rates Is Exaggerated. *The Conversation*. Retrieved March 19, 2018, from <https://theconversation.com/anti-vaxxer-effect-on-vaccination-rates-is-exaggerated-92630>
- Wang, E., Clymer, J., Davis-Hayes, C., & Bутtenheim, A. (2014). Nonmedical Exemptions from School Immunization Requirements: A Systematic Review. *American Journal of Public Health*, 104(11), e62–e84.
- Wenger, O. K., McManus, M. D., Bower, J. R., & Langkamp, D. L. (2011). Underimmunization in Ohio's Amish: Parental Fears Are a Greater Obstacle than Access to Care. *Pediatrics*, 128(1), 79–85.
- WHO. (2014). *Report of the SAGE Working Group on Vaccine Hesitancy*. Retrieved March 2018, from http://www.who.int/immunization/sage/meetings/2014/october/1_Report_WORKING_GROUP_vaccine_hesitancy_final.pdf
- WHO. (2018). *Europe Observes a 4-fold Increase in Measles Cases in 2017 Compared to Previous Year*. Retrieved March 15, 2018, from <http://www.euro.who.int/en/media-centre/sections/press-releases/2018/europe-observes-a-4-fold-increase-in-measles-cases-in-2017-compared-to-previous-year>

Open Access This chapter is licensed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>), which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

