AperTO - Archivio Istituzionale Open Access dell'Università di Torino

Healthcare Workers' (HCWs) attitudes towards mandatory influenza vaccination: A systematic review and meta-analysis

This is a pre print version of the following article:

Original Citation:

Availability:

This version is available <http://hdl.handle.net/2318/1767883> since 2021-01-20T15:34:07Z

Published version:

DOI:10.1016/j.vaccine.2020.12.061

Terms of use:

Open Access

Anyone can freely access the full text of works made available as "Open Access". Works made available under a Creative Commons license can be used according to the terms and conditions of said license. Use of all other works requires consent of the right holder (author or publisher) if not exempted from copyright protection by the applicable law.

(Article begins on next page)

1 Gualano MR, Corradi A, Voglino G, Catozzi D,
2 Olivero E, Corezzi M, Bert F, Siliquini R.
3 Healthcare Workers' (HCWs) attitudes towards
4 mandatory influenza vaccination: A systematic
5 review and meta-analysis. *Vaccine*. 2021 Jan
6 12:S0264-410X(20)31655-8. doi:
7 10.1016/j.vaccine.2020.12.061. Epub ahead of
8 print. PMID: 33451776.
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24

25 **Abstract**

26 Influenza is a disease responsible for thousands of deaths every year. Although healthcare workers
27 (HCWs) represent a way of contagion for patients, vaccination coverage among them is low.
28 Mandatory vaccination has been proposed, but controversies remain. This systematic review and
29 meta-analysis aimed to assess the acceptance of mandatory vaccination by HCWs, and to investigate
30 associated characteristics. MEDLINE, Scopus, Embase, PsycInfo, CINAHL and Web of Science
31 were used to search for studies assessing the topic. PRISMA statements were followed. Of the 13457
32 univocal records found, 52 studies were included in the systematic review and 40 in the meta-analysis.
33 The pooled proportion of HCWs accepting the policy was of 61% (95% CI: 53%-68%) but with great
34 heterogeneity between continents (from 54% in Europe to 69% in Asia) and in different professionals
35 (from 40% in nurses to 80% in students). Vaccinated HCWs agreed more frequently with mandatory
36 vaccination than non-vaccinated ones. More studies that consider mandatory vaccination acceptance
37 as the main outcome are needed, but the results of this study confirm that physicians and HCWs
38 vaccinated against flu favour mandatory vaccination. This, combined with effects that a flu epidemic
39 could have if overlapped to pandemics with similar symptoms, requires renewed considerations on
40 mandatory vaccination.

41 **Keywords**

42 Influenza, Human; Vaccination; Immunization Programs; Health Personnel

43

44 **Introduction**

45 Influenza is a highly contagious acute respiratory illness characterized by fever, cough, headache,
46 muscle and joint pain, severe malaise (feeling unwell), sore throat and runny nose. The symptoms
47 range from mild to severe and can even cause death, due to complications.(*WHO Fact Sheet on*
48 *Influenza*, n.d.) This condition affects approximately between 5% to 10% of the general population
49 every year, predominantly during the winter season of each hemisphere, leading to 3 - 5 million cases
50 of severe illness and about 290,000 to 650,000 respiratory deaths.(*WHO Fact Sheet on Influenza*,
51 n.d.) The most effective way to prevent the infection is the seasonal vaccination.(Osterholm et al.,
52 2012) WHO recommends annual vaccination for pregnant women at any stage of pregnancy, children
53 aged between 6 months to 5 years, elderly individuals (aged more than 65 years), patients with chronic
54 medical conditions and health-care workers (HCWs).(*WHO Fact Sheet on Influenza*, n.d.) In fact,
55 different studies demonstrated that HCWs play a crucial role in the infection spreading to.(Ghendon,
56 1992; Potter et al., 1997) A review showed how vaccinating HCWs reduces influenza illness by 29%,
57 medical consultations by 52%, and all-cause mortality by 55% in elderly people(Rivetti et al., 2006)
58 and decreases the risk of illness-related absenteeism for themselves.(Gianino et al., 2019; Imai et al.,
59 2018) Despite the strong recommendations provided, influenza vaccination rates among HCWs are
60 globally well below targets set by WHO, proving how vaccine hesitancy is a phenomenon recorded
61 even among health professionals.(Blank et al., 2009; Elawad et al., 2017; Ghandora et al., 2019;
62 Jorgensen et al., 2018; Seale et al., 2011; To et al., 2016)

63 A review published in 2012 tried to assess different interventions used to increase vaccination uptake
64 among HCWs.(Hollmeyer et al., 2013) Ten types of intervention measures were analysed: free
65 vaccine, flexible worksite vaccine delivery, education material, education sessions, reminders,
66 incentives, assignment of dedicated staff, feedback, signed declination statements and mandatory
67 vaccination. The assessment revealed that programmes using more interventions achieved higher
68 vaccine coverage. Among specific strategies reported to have higher success rates, free vaccination

69 seems to be crucial. The most effective intervention, however, appears to be a mandatory vaccination
70 policy for healthcare workers.(Hollmeyer et al., 2013)
71 Even though mandatory vaccination strategies showed their efficacy, this type of intervention is still
72 considered controversial.(Hollmeyer et al., 2013; Isaacs & Leask, 2008; Lorenc et al., 2017; Lugo,
73 2007) Opponents affirm that a similar policy would violate their personal autonomy and the right to
74 take medical decisions concerning their body.(Isaacs & Leask, 2008; Lugo, 2007) On the other hand,
75 supporters claim that a mandate meets the professional values to do no harm and to act in patients'
76 best interests.(Anikeeva et al., 2009; Rea & Upshur, 2001)
77 Despite their subjective worthiness, some of these objections may shatter in the presence of the
78 current global emergency due to the novel Coronavirus (Sars-CoV-2), causing upper and lower
79 respiratory symptoms hardly distinguishable from influenza in the early stage.(MacDonald et al.,
80 2015; Wu et al., 2020)
81 Influenza vaccine acceptability among healthcare professionals will be inevitably tested during the
82 incoming winter season. Vaccination of all HCWs will play a key role during the next future, with
83 the goal to avoid sickness from a preventable disease in a time of possible shortage of manpower.
84 The aim of the present review and meta-analysis is to assess attitudes towards mandatory influenza
85 vaccination programs among HCWs, to plan the best intervention to increase vaccination uptake.

86

87 **Methods**

88 The present review followed the Preferred Reporting Items for Systematic Review and Meta-analysis
89 (PRISMA) statement.(Liberati et al., 2009)

90

91 *Search strategy and selection criteria*

92 A systematic search of scientific literature was performed on MEDLINE (via PubMed), Scopus,
93 Embase, PsycInfo (via EBSCO), CINAHL (Cumulative Index of Nursing and Allied Health

94 Literature) (via EBSCO), Web of Science. Research strings and inclusion/exclusion criteria were
95 defined a priori.

96 The research string was obtained customizing for each research engine the following structure:
97 {[Healthcare Workers (with synonyms and plurals)] OR [HCWs declinations (such as clinician,
98 doctor, nurse, health students)] OR “Health Personnel”[mesh] OR “Students, Health
99 Occupations”[mesh]} AND {“Vaccines”[mesh] OR [vaccine, vaccination, immunization synonyms
100 and plurals] AND [“Influenza,Human”[mesh] OR [influenza, flu and variations]] OR “Influenza
101 Vaccines”[mesh]} AND {“Mandatory Programs”[mesh] OR mandatory, requirement, required,
102 obligatory, policy, law (various declinations with synonyms and plurals)}. More info on research
103 strings used can be found in Supplementary Materials.

104 No filters were applied except for publication year ≥ 2000 . Thus, search results span from the 1st Jan
105 2000 to the 12th Nov 2019. No language restrictions were set in this stage.

106 Studies investigating attitudes towards compulsory influenza vaccination of HCWs were considered.
107 In the present study, all the individuals working in medical facilities, both in primary, secondary, and
108 tertiary care settings were considered HCWs. In addition, students of health-related subjects were
109 included, if they were carrying out an internship or training in a medical facility during their courses.
110 Because of the recent cultural changes concerning compulsory vaccination and the increased attention
111 to the issue of vaccine hesitancy,(MacDonald et al., 2015) only studies performed after the year 2000
112 were included. Due to the extensive alarm, attention and media coverage over H1N1 Pandemic
113 Influenza during winter season 2009-2010, with a possible increase in perceived risk and attitudes
114 toward mandatory vaccination, authors agreed to exclude papers focusing exclusively on H1N1
115 vaccine from the present review.

116 Studies were considered eligible for inclusion if: 1) They interviewed HCWs; 2) They consisted in
117 structured or semi-structured surveys assessing attitudes towards compulsory influenza vaccination
118 of HCWs; 3) They were full papers presenting original data, published with a peer-reviewed process

119 on scientific journals; 4) They were written in English, Italian, French, Spanish or German; 5) They
120 were published after year 2000.

121 No restrictions were performed based on sample size or setting of the survey.

122 However, studies were excluded if: 1) They assessed vaccination coverage but not the attitudes
123 towards compulsory vaccination; 2) They focused exclusively on H1N1 pandemic influenza; 3) They
124 do not provide original data or do not present them in a full text fashion.

125 Finally, a meta-analysis was performed to investigate attitudes of HCWs about compulsory influenza
126 vaccination. In addition to the inclusion and exclusion criteria previously mentioned, studies were
127 considered eligible for the meta-analysis if: 1) The relevant question was proposing mandatory
128 vaccination of the same group of HCWs who were answering to the question; 2) The question was
129 clearly expressed, and the hypothetical mandate was not amended by specific conditions (e.g. “Only
130 for those HCWs...”); 3) The outcome was clearly delivered as proportion/percentage of favourable
131 HCWs directly by authors or plainly ascribable to this meaning from original data.

132 Studies were excluded if: 1) They assessed attitudes towards compulsory vaccination exclusively in
133 health care facilities managers, administrators, or policy makers; 2) They did not clearly express the
134 outcome.

135 If the study was providing them, data were collected also for specific HCWs categories, referred in
136 the present work as “subsamples”. In particular, specific data was collected by analysing influenza
137 vaccination status (vaccinated, not vaccinated), occupation (physician, nurse, student, general
138 practitioner) and category of occupation [clinic (physician, nurse...), non-clinic (administration
139 personnel...)]. Each subsample that was reported in a sufficient number of studies was then furtherly
140 analysed, as a single or in comparison with other subsamples, as described in the “Statistical analysis”
141 section.

142 After duplicates removal, five researchers (MC, EO, GV, AC and DC) screened results by title and
143 abstract. Every study was evaluated by 2 reviewers independently. Irrelevant or duplicated papers
144 were excluded. Studies regarding the attitude towards influenza vaccination in HCWs not explicitly

145 mentioning questions about mandate were provisionally allowed to proceed the selection process to
146 prevent the rejection of suitable studies due to incomplete abstract compilation.

147 In case a selected publication consisted in abstract alone, Researchers attempted to search for a full
148 publication from the authors. If no full text version of the study was found, abstract was discarded in
149 accordance with exclusion criteria.

150 Selection conflicts were resolved reaching consensus or by a third reviewer's advice. This method
151 was adopted during both selection phases: the first one based on title and abstract, and the second one
152 based on full text, resulting in the final inclusion of papers in the systematic review results.

153 Reasons for exclusion are displayed in PRISMA flow diagram (Figure 1): wrong outcome
154 (intervention studies, vaccine coverage studies, surveys without an item about mandatory vaccination
155 or not explicitly referred to influenza vaccination), wrong literature (studies consisting in an abstract
156 alone, letters to the editor, secondary literature or book chapters), wrong context (studies considering
157 different vaccines or diseases such as mumps, measles, or H1N1 influenza), true or false duplicates,
158 wrong population (such as hospital managers, patients, parents or stakeholders), language limitations.

159

160 *Data extraction and quality assessment*

161 The researchers independently extracted data from the full-text version of the selected studies,
162 collecting information about the country in which the study was performed, the characteristics of the
163 sample, the questionnaire used, the relevant question and the results of the study.

164 Quality assessment of the selected evidence, as stated by expert groups such as The Cochrane
165 Collaboration,(Higgins JPT, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, 2019) consists in
166 interpreting the results highlighting methodological quality and risk of bias, in order to detect if study
167 design befits the research question. On this occasion, a piece of information such as the attitude
168 toward mandatory vaccination was only occasionally the main outcome of the questionnaires
169 administered, and thus it was difficult to assess if the variable of interest was properly collected.

170

171 *Statistical analysis*

172 Microsoft Office suite software (Microsoft Corp., Redmond, WA) was employed to manage
173 duplicates removal of extracted data, selection process and data extraction. The R software,(R Core
174 Team (2020), n.d.) and in particular meta(Balduzzi et al., 2019) and metafor(Viechtbauer, 2010)
175 packages were used to perform meta-analyses.

176 Fixed effects models require the assumption that a common, underlying effect across studies is
177 present. However, this work analysed the attitude towards mandatory influenza vaccination policies
178 in studies conducted worldwide, with different populations and different sampling methods.

179 Given that the assumption of common effect across studies was not able to be made, random effects
180 models were used.(Higgins et al., 2009)

181 A generalised linear mixed model (Logit transformation, Maximum-likelihood estimator for τ^2) was
182 performed for the meta-analyses of full sample proportions(Schwarzer et al., 2019; Stijnen et al.,
183 2010) in all the studies yielding comparable outcomes. Specific, similar meta-analyses were
184 performed for every subsample of HCWs if data was sufficient (e.g. vaccinated and not vaccinated
185 HCWs).

186 In the case of full sample proportions, a by continent subgroup random-effects model was also
187 utilized. Subgroup differences were assessed with a random-effects model.(Borenstein & Higgins,
188 2013)

189 Moreover, relative risks between subsamples within each study were calculated if the number of
190 studies reporting stratified figures was sufficient to perform a subsequent meta-analysis (>4) and if
191 subsample analysis reported proportions different among them, so that the proportion of a subsample
192 was not included in 95% CI of the other subgroup.

193 Then, a meta-analysis of relative risks was performed and, if possible, stratified by continent (Mantel-
194 Haenszel method, Paule-Mandel estimator for τ^2 , Hartung-Knapp adjustment for random effects
195 model).(Veroniki et al., 2016) In case of subgroup differences or significant heterogeneity, a meta-
196 regression model of relative risks was performed (Paule-Mandel estimator for τ^2 , Hartung-Knapp

197 adjustment for random effects model). Potential moderators investigated were continent and year of
198 publication.

199 A funnel plot was drawn, and an Egger's test was performed in order to check publication bias and
200 small-study effect, although the use of these methods in meta-analysis of proportions are under
201 debate(Maulik et al., 2011) and results must be treated with caution. However, not standard error but
202 size of the study was used in funnel plot drawing, as suggested by Hunter et al.(Hunter et al., 2014)
203 Additionally, subsample funnel plots were drawn to investigate differences between continents.
204 The Cochran Q, τ^2 , and the I^2 were used to evaluate heterogeneity of studies.

205

206 **Results**

207 A total of 13457 univocal articles were retrieved from the scientific databases analysed (MEDLINE,
208 Embase, Scopus, CINAHL, PsycInfo, Web of Science). After duplicates removal (7115 results), the
209 remaining papers were screened by title and abstract, and 6864 were excluded because not relevant,
210 resulting in 251 studies eligible for the full text review. Of the eligible studies, 199 were subsequently
211 excluded because they did not respect the inclusion criteria (Figure 1). In particular, 72 studies were
212 excluded for wrong outcome, 64 came from wrong literature, 24 considered a different context, 21
213 were found to be true or false duplicates, 17 studies selected a different population, and finally 1 study
214 was excluded due to language limitations (Polish).

215 Then, 52 studies (shown in Table 1) were selected for the systematic review.(Akan et al., 2016;
216 Alsuhaibani, 2020; Awali et al., 2014; Bali et al., 2013; Banach et al., 2013; Bazán et al., 2017; Boey
217 et al., 2018; Chor et al., 2011; DeSante et al., 2010; Douville et al., 2010; Durando et al., 2016;
218 Feemster et al., 2011; Ghandora et al., 2019; Gianfredi et al., 2019; Goldstein et al., 2004; Hakim et
219 al., 2011; Halpin & Reid, 2019; Haridi et al., 2017; Hubble et al., 2011; Hudu et al., 2016;
220 Karageorgou et al., 2014; Kent et al., 2010; Kyaw et al., 2019; La Torre et al., 2017; LaVela et al.,
221 2015; Leask et al., 2010; Lester et al., 2003; Looper et al., 2017; Maltezou et al., 2013; Maltezou,
222 Gargalianos, et al., 2012; Maltezou, Lourida, et al., 2012; Maurer et al., 2012; Naleway et al., 2014;

223 Nicolay et al., 2008; Pichon et al., 2019; Pless et al., 2017; Poland et al., 2008; Polgreen et al., 2010;
224 Quintyne et al., 2018; Rebmann et al., 2012a, 2012b, 2016; Saluja et al., 2005; Sánchez & García-
225 Fragoso, 2013; Seale et al., 2011; Shrikrishna et al., 2015; Thompson et al., 2013; Walker et al., 2016;
226 S. Wicker et al., 2011; Sabine Wicker et al., 2010; Willis & Wortley, 2007; Yue et al., 2019)
227 Finally, 40 of the previous studies were selected for the quantitative synthesis of evidence (meta-
228 analysis).

229

230 *Main findings*

231 The 52 studies included in the systematic review were published between 2003(Lester et al., 2003)
232 and September 2019.(Alsuhaibani, 2020; Gianfredi et al., 2019) In regards to the continent where the
233 studies took place, 26 were conducted in Northern or Central America, 16 were conducted in Europe,
234 3 in Oceania, 6 in Asia, and 1 study collected data both from Europe and Asia.(Chor et al., 2011)
235 Most represented country was the USA, with 21 studies included. The sample size for the studies
236 ranged from 18(Pless et al., 2017) to over 5141 subjects interviewed,(Boey et al., 2018) with a median
237 of 572.5 and an IQR of 1129.25. Population samples were very different, but most of the studies
238 enrolled physicians, nurses, or both. Almost all the studies collected data with anonymous self-
239 administered questionnaires of various types (web-based, mailed, paper-based, telephone-based).
240 Finally, one study reported results of focus group,(Willis & Wortley, 2007) while another
241 described.(Pless et al., 2017)

242 Regarding the 40 studies included in meta-analysis, 19 were conducted in Northern or Central
243 America, 5 in Asia, 12 in Europe, 3 in Oceania, and 1 collected data from both Europe and Asia.(Chor
244 et al., 2011) Among these studies, fifteen reported the relevant data stratified for vaccination status
245 both for vaccinated and unvaccinated HCWs,(Akan et al., 2016; Awali et al., 2014; Banach et al.,
246 2013; Douville et al., 2010; Hakim et al., 2011; Haridi et al., 2017; Kyaw et al., 2019; Lester et al.,
247 2003; Maurer et al., 2012; Poland et al., 2008; Quintyne et al., 2018; Rebmann et al., 2012a, 2012b;

248 Seale et al., 2011; Walker et al., 2016) while eight studies reported the figure for physicians,(Akan et
 249 al., 2016; Alsuhaibani, 2020; Boey et al., 2018; DeSante et al., 2010; Douville et al., 2010; Lester et
 250 al., 2003; Polgreen et al., 2010; Quintyne et al., 2018; S. Wicker et al., 2011) five for
 251 nurses,(Alsuhaibani, 2020; Douville et al., 2010; Poland et al., 2008; Quintyne et al., 2018; Sabine
 252 Wicker et al., 2010) five for students(Banach et al., 2013; Gianfredi et al., 2019; Looper et al., 2017;
 253 Walker et al., 2016; S. Wicker et al., 2011) and two for general practitioners.(Akan et al., 2016;
 254 Alsuhaibani, 2020) Of these, only four studies reported the relevant data for both physicians and
 255 nurses.(Alsuhaibani, 2020; DeSante et al., 2010; Douville et al., 2010; Quintyne et al., 2018; Sabine
 256 Wicker et al., 2010) Full summarized data about studies included is shown in Table 1.

257 Funnel plot (Figure 2) did not visually suggest publication bias, and this result was consistent with
 258 Egger's regression test ($p=0.337$). Funnel plots stratified by continent suggested a publication bias
 259 trend in Europe only (Figure 3). However, Egger's regression test showed no significant correlation
 260 in this subsample ($p=0.690$).

261 The pooled proportion of agreement with mandatory vaccination policies in HCWs was 0.61 (95%
 262 CI: 0.53-0.68). A very high heterogeneity was shown ($I^2 = 99\%$). Figure 4 reports the proportion of
 263 each subgroup by continent, which varied from 0.54 (Europe) to 0.69 (Asia). A statistically significant
 264 difference between subgroups was not able to be found ($p = 0.558$).

265 Meta-analyses of subsamples results are summarized in Table 2. Since data of each subsample was
 266 not independent regarding other subsamples, comparison between these subsamples was not
 267 explored.

268 Because of the scarce number of studies reporting stratified subsample data, calculation of RRs and
 269 subsequent meta-analysis was possible only regarding vaccination status. In particular, sixteen studies
 270 were included.(Akan et al., 2016; Awali et al., 2014; Banach et al., 2013; Boey et al., 2018; Douville
 271 et al., 2010; Hakim et al., 2011; Haridi et al., 2017; Kyaw et al., 2019; Lester et al., 2003; Maurer et
 272 al., 2012; Poland et al., 2008; Quintyne et al., 2018; Rebmman et al., 2012a, 2012b; Seale et al., 2011;
 273 Walker et al., 2016) Vaccinated HCWs had an increased "risk" to agree with mandatory vaccination

274 policies, and the difference between vaccinated and non-vaccinated HCWs was statistically
275 significant (RR: 1.94; 95% C.I.: 1.48-2.55, $p < 0.01$), although in presence of high heterogeneity ($I^2 =$
276 97%). Then, a subgroup, by continent meta-analysis was performed. Due to issues in the number of
277 studies, only studies from America and Asia were retained (Figure 5). The RR of vaccinated HCWs
278 to agree with mandatory vaccination policies compared to non-vaccinated HCWs in American studies
279 was of 2.13 (95% C.I.: 1.48-3.07, $p < 0.01$), while in Asian ones was of 1.19 (95% C.I.: 0.95-1.49,
280 $p = 0.08$). Since the difference between subgroups was statistically significant ($p < 0.01$), a meta
281 regression was performed. Results are summarized in Table 3. The estimate effect is expressed as the
282 log of RR. Continent accounted for 29.96% of the heterogeneity observed in the sample, and
283 moderators' effect was statistically significant ($p = 0.0496$).

284 Finally, 12 studies were included in the systematic review because they reported the outcome of
285 interest but were excluded from the meta-analysis because the outcome was expressed in a way not
286 suitable for a meta-analytic process (e.g. qualitative studies). Main findings are briefly reported.
287 Goldstein and colleagues reported 40% of the HCWs interviewed supported mandatory vaccination
288 as a state-wide law for workers with direct patient contact, and 49% as a facility-wide
289 regulation. (Goldstein et al., 2004) A work describing data from Indian HCWs reported an 88% of
290 support for mandatory vaccination of those workers employed in high-risk areas such as
291 oncology. (Bali et al., 2013) Similar results but in a different population were reported by Karageorgou
292 et al.: medical students were asked to imagine that their parents were hospitalized with a COPD
293 diagnosis. With these assumptions, the 84.7% of the students stated that they supported mandatory
294 vaccination for HCWs. (Karageorgou et al., 2014) Several qualitative studies as the one performed by
295 Pless and colleagues (Pless et al., 2017) reported that nurses criticized mandatory mask because of
296 fear of stigmatization, while declination form was considered a good approach; moreover, mandate
297 for already employed HCWs was considered unacceptable, while it was considered acceptable as a
298 requisition for hiring. Another study describing findings of focus groups reported that some nurses

299 stated mandatory vaccination could increase opportunities to take vaccination, but others opposed the
300 policy, having concerns about disciplinary actions.(Willis & Wortley, 2007) Along the same line,
301 50% of unvaccinated HCWs declared that mandatory vaccination could influence their choice to be
302 vaccinated,(Thompson et al., 2013) and in Naleway's study, 52% of enrolled HCWs declared they
303 would have been vaccinated if it were mandatory.(Naleway et al., 2014) In a Canadian work, 60.9%
304 of the medical, nursing and pharmacy students interviewed supported mandatory vaccination or mask
305 policy.(Ghandora et al., 2019) Very low support was found among emergency medical technicians,
306 with 9.1% of the sample supporting mandatory vaccination and 38.7% supporting it with decline
307 option.(Hubble et al., 2011) Indeed, in a sample of 672 HCWs (physicians, nurses, midwives,
308 administrative staff) only 1.04% declared that mandatory vaccination was the best strategy to improve
309 vaccination rates.(Bazán et al., 2017) Finally, two studies investigated HCWs attitude with a Likert
310 scale. The first reported a median of 5 in a scale with 1 as "not at all" and 10 as "absolutely yes" in
311 agreement with mandatory vaccination with bimodal distribution towards the extreme scores (IQR
312 8).(Pichon et al., 2019) The other used a scale from 1 (strongly agree) to 5 (strongly disagree) and
313 described results stratified for vaccination status: median of 2 for vaccinated HCWs and of 4 for
314 unvaccinated ones.(Shrikrishna et al., 2015)

315 **Discussion**

316 The present systematic review and meta-analysis, conducted following the PRISMA Statements,
317 investigated Healthcare Workers (HCW) attitudes towards mandatory influenza vaccination.(Liberati
318 et al., 2009) An evident publication bias was not possible to be found; however, difference among
319 continents exists, with Europe being currently the continent where a bias for publication seems more
320 possible, and future researchers should keep this finding in mind.

321 Although compulsory vaccination has been presented as the most effective strategy to contrast
322 vaccine hesitancy among this specific population at risk,(Hollmeyer et al., 2013) the HCWs attitudes
323 cannot be defined unanimously.(Anikeeva et al., 2009; Hollmeyer et al., 2013; Isaacs & Leask, 2008;

324 Lugo, 2007; Rea & Upshur, 2001) In the present work, a great amount of heterogeneity between
325 studies was found. Although part of this finding can be explained by differences in geographical
326 areas, the most is due to differences in the sampling method of the HCWs population among selected
327 studies. While some studies interviewed a single category of personnel, the majority pooled together
328 different types of HCWs, basing sampling on opportunistic reasons. For this reason, researchers
329 assessing attitudes in HCWs should focus on reporting subsample data as often as possible.

330 It is difficult to define if HCWs favour mandatory flu vaccination. On one hand, the majority of
331 HCWs declared to be favourable to this policy, except in Europe. On the other hand, given that the
332 measure would affect all HCWs and not only those that are in favour with it, it could be argued that
333 greater percentages than the simple 50% majority are needed, before enforcing mandatory vaccination
334 on the sole basis of its acceptance. However, other factors must be considered. Patient's safety,
335 workdays lost, and the risk of flu being mistaken for more dangerous diseases such as COVID-19,
336 should suffice in supporting policy makers who decide to take this route.

337 In addition, the incoming 2020 flu season and maybe subsequent ones will pose a challenge towards
338 all healthcare systems, given that flu and COVID-19 contagion curves could well overlap.
339 Furthermore, COVID-19 initial symptoms are often indistinguishable from flu ones: this could lead
340 to massive quarantine measures, emptying hospital services; or, in order to prevent this scenario,
341 policy makers could ease quarantine measures involving medical personnel, possibly leading to even
342 more dramatic outcomes, with COVID-19 freely circulating among healthcare professionals.

343 Nonetheless, future researchers should focus on better understanding of factors that modify
344 mandatory vaccination acceptance and overall flu vaccine acceptance, deepening cultural and
345 national differences, and, no less important, differences among HCWs categories. Furthermore, after
346 COVID-19 worldwide emergency, the attitude towards flu vaccination could have changed, and it
347 will be interesting to compare data in the present study with post-pandemic data.

348 The meta-analysis returned that the pooled proportion of HCWs who favour a mandatory vaccination
349 plan is 61% (95%C.I.: 53%-68%). This percentage ranged from 15.4% in a sample of emergency

350 medical technicians and paramedics from the USA(Rebmann et al., 2012a) to 93.1% among the
351 Students from the University of Oklahoma Health Sciences Center.(Looper et al., 2017) Interestingly,
352 when the subjects interviewed are not the ones personally involved in the vaccination the attitudes
353 are generally more supportive towards compulsory vaccination. A study focused on interviewing
354 parents and guardians of children hospitalized at Arkansas Children's Hospital, USA: 76% of the 372
355 respondents thought that HCWs should receive an annual influenza vaccination and that it should be
356 mandatory.(Linam et al., 2014) The results are in line with the ones that emerged when assessing
357 parents' attitude towards mandatory vaccinations. In fact, a previous review outlined how the parents'
358 support to this kind of policy ranged from 53% to 97% for different vaccination programs.(Gualano
359 et al., 2019; Krok-Schoen et al., 2018; Perkins et al., 2010) Similarly, 93.1% of the faculty members
360 of an American University agreed or strongly agreed that flu vaccination is appropriate for,(Looper
361 et al., 2017) confirming the healthcare students' positive attitudes towards compulsory vaccination
362 policies.(Ghandora et al., 2019; Karageorgou et al., 2014) However, previous studies assessed
363 HCWs' attitudes towards mandatory childhood and adult vaccination, pointing out how the level of
364 acceptance of this kind of policies is generally lower among this specific population compared to
365 parents' attitudes.(Gualano et al., 2019)

366 Most of the studies assessed the attitudes towards compulsory vaccination policies addressed to
367 HCWs in general, but some of them focused on HCWs in specific high-risk settings. In these cases
368 the acceptance of mandatory vaccination was higher probably because of the increased perceived risk
369 for the patient (such as in the oncology or paediatrics wards),(Bali et al., 2013; Little et al., 2015;
370 Maltezou et al., 2013; Maltezou, Lourida, et al., 2012) or because of the increased risk for the
371 professionals (such as in the emergency department).(Hubble et al., 2011; Little et al., 2015)

372 The relative risks meta-analysis performed found a statistically significant result, namely a positive
373 association between vaccine acceptance and attitude towards mandatory vaccination for all HCWs.
374 As previous studies did, the association between accepting the vaccination and accepting mandatory
375 vaccination strategies must be underlined.(Gualano et al., 2018) However, the subgroup analysis

376 performed stratifying by continent showed different scenarios. In American studies, the association
377 maintained its statistical significance, while in Asian ones the RR lowered to almost 1, with a p-value
378 major than 0.05. This finding, together with overall higher percentages of vaccinated HCWs in Asian
379 countries, could mean that in America the HCW who has negative attitudes towards mandatory flu
380 vaccination successfully achieves to not be vaccinated, while personal attitude loses importance in
381 Asian studies. On the other hand, a lower RR in Asian studies could mean that HCWs are in general
382 not contrary towards mandatory flu vaccination; however, both favourable and unfavourable HCWs
383 choose to vaccinate themselves because of other reasons, such as personal beliefs or opinion on side
384 effects and efficacy. Nonetheless, this finding was drawn from a very limited number of studies,
385 especially in the Asian subgroup (3 studies which took place in Turkey, Saudi Arabia,
386 Singapore),(Akan et al., 2016; Haridi et al., 2017; Kyaw et al., 2019) and for this reason this evidence
387 should be treated as a point of reflection for future studies rather than a finding generalizable to the
388 Asian continent.

389 The meta regression findings were consistent with those of the subgroup's analysis and confirmed
390 that continents' differences accounts for a good part of heterogeneity in this comparison between
391 American and Asian studies ($R^2 = 29.96\%$).

393 Our review has some limitations that should be reported. To be as comprehensive as possible, we did
394 not exclude any study based on sample size, which varied considerably among studies. Additionally,
395 great heterogeneity was present among studies. Major differences regarded the sample composition,
396 with different kinds of HCWs, interviewed in different countries. However, this limitation was
397 partially tackled with subgroup meta-analysis and meta regression. Finally, we limited the research
398 including only studies published after 2000, and thus this work cannot give insight further back than
399 that date.

400 Nevertheless, this work also has strengths. To our best knowledge, it is the first systematic review on
401 HCWs attitude towards mandatory vaccination. In addition, the large sample of studies included gives

402 an overall view of the topic on a global scale, while subgroups analyses help deepen some findings
403 and raise hypotheses on characteristics correlated with the outcome.

404 **Conclusion**

405 The aim of the study was to give a quantitative estimate of the acceptance of mandatory vaccination
406 policies among HCWs. In fact, low coverage for the flu vaccine is a remarkable issue globally(Blank
407 et al., 2009; Elawad et al., 2017; Ghandora et al., 2019; Jorgensen et al., 2018; Seale et al., 2011; To
408 et al., 2016) and this kind of strategy resulted to be effective to reduce the impact of the influenza
409 infection.(Hollmeyer et al., 2013) The results of this work could represent a strong tool to support
410 evidence-based policy making, and the starting point for new works that will investigate acceptance
411 of flu vaccination in HCWs.

412 **Acknowledgments**

413 ***Funding***

414 The research did not receive any specific grant from funding sources in the public, commercial or
415 not-for-profit sectors. All authors had full access to the full data in the study and accept responsibility
416 to submit for publication.

417 ***Conflicts of Interest***

418 The authors declare no conflict of interest

419 **Figure captions**

420 Figure 1 – PRISMA flow diagram.

421 Figure 2 – Publication bias assessment, funnel plot – whole sample

422 Figure 3 – Publication bias assessment, funnel plot – whole sample, stratified by continent

423 Figure 4 – Pooled percentage of HCWs who agree with mandatory flu vaccination policies, forest
424 plot – whole sample, stratified by continent

425 Figure 5 – Pooled relative risk for the association between vaccination status and agreement with
426 mandatory flu vaccination policies, forest plot – subsample, stratified by continent

427 **References**

- 428 Akan, H., Yavuz, E., Yayla, M. E., Külbay, H., Kaspar, E., Zahmacioğlu, O., & Badur, S. (2016).
 429 Factors affecting uptake of influenza vaccination among family physicians. *Vaccine*, 34(14),
 430 1712–1718. <https://doi.org/10.1016/j.vaccine.2016.01.057>
- 431 Alsuhaibani, M. (2020). Barriers and beliefs among health-care workers regarding seasonal
 432 influenza vaccine in Al-Qassim region, Saudi Arabia. *Human Vaccines and*
 433 *Immunotherapeutics*, 16(2), 313–320. <https://doi.org/10.1080/21645515.2019.1656020>
- 434 Anikeeva, O., Braunack-Mayer, A., & Rogers, W. (2009). Requiring influenza vaccination for
 435 health care workers. In *American Journal of Public Health* (Vol. 99). American Public Health
 436 Association. <https://doi.org/10.2105/AJPH.2008.136440>
- 437 Awali, R. A., Samuel, P. S., Marwaha, B., Ahmad, N., Gupta, P., Kumar, V., Ellsworth, J.,
 438 Flanagan, E., Upfal, M., Russell, J., Kaplan, C., Kaye, K. S., & Chopra, T. (2014).
 439 Understanding health care personnel's attitudes toward mandatory influenza vaccination.
 440 *American Journal of Infection Control*, 42(6), 649–652.
 441 <https://doi.org/10.1016/j.ajic.2014.02.025>
- 442 Balduzzi, S., Rücker, G., & Schwarzer, G. (2019). How to perform a meta-analysis with R: A
 443 practical tutorial. *Evidence-Based Mental Health*, 22(4), 153–160.
 444 <https://doi.org/10.1136/ebmental-2019-300117>
- 445 Bali, N. K., Ashraf, M., Ahmad, F., Khan, U. H., Widdowson, M. A., Lal, R. B., & Koul, P. A.
 446 (2013). Knowledge, attitude, and practices about the seasonal influenza vaccination among
 447 healthcare workers in Srinagar, India. *Influenza and Other Respiratory Viruses*, 7(4), 540–545.
 448 <https://doi.org/10.1111/j.1750-2659.2012.00416.x>
- 449 Banach, D. B., Zhang, C., Factor, S. H., & Calfee, D. P. (2013). Support for mandatory health care
 450 worker influenza vaccination among allied health professionals, technical staff, and medical
 451 students. *American Journal of Infection Control*, 41(4), 354–356.
 452 <https://doi.org/10.1016/j.ajic.2012.05.019>
- 453 Bazán, M., Villacorta, E., Barbagelatta, G., Jimenez, M. M., Goya, C., Bartolini, R. M., & Penny,
 454 M. E. (2017). Health workers' attitudes, perceptions and knowledge of influenza
 455 immunization in Lima, Peru: A mixed methods study. *Vaccine*, 35(22), 2930–2936.
 456 <https://doi.org/10.1016/j.vaccine.2017.04.021>
- 457 Blank, P. R., Schwenkglenks, M., & Szucs, T. D. (2009). Vaccination coverage rates in eleven
 458 European countries during two consecutive influenza seasons. *Journal of Infection*, 58(6),
 459 446–458. <https://doi.org/10.1016/j.jinf.2009.04.001>
- 460 Boey, L., Bral, C., Roelants, M., De Schryver, A., Godderis, L., Hoppenbrouwers, K., &
 461 Vandermeulen, C. (2018). Attitudes, believes, determinants and organisational barriers behind
 462 the low seasonal influenza vaccination uptake in healthcare workers – A cross-sectional
 463 survey. *Vaccine*, 36(23), 3351–3358. <https://doi.org/10.1016/j.vaccine.2018.04.044>
- 464 Borenstein, M., & Higgins, J. P. T. (2013). Meta-Analysis and Subgroups. *Prevention Science*,
 465 14(2), 134–143. <https://doi.org/10.1007/s11121-013-0377-7>

- 466 Chor, J. S. Y., Pada, S. K., Stephenson, I., Goggins, W. B., Tambyah, P. A., Clarke, T. W., Medina,
467 M., Lee, N., Leung, T. F., Ngai, K. L. K., Law, S. K., Rainer, T. H., Griffiths, S., & Chan, P.
468 K. S. (2011). Seasonal influenza vaccination predicts pandemic H1N1 vaccination uptake
469 among healthcare workers in three countries. *Vaccine*, 29(43), 7364–7369.
470 <https://doi.org/10.1016/j.vaccine.2011.07.079>
- 471 DeSante, J. E., Caplan, A., Shofer, F., & Behrman, A. J. (2010). Physician attitudes towards
472 influenza immunization and vaccine mandates. *Vaccine*, 28(13), 2517–2521.
473 <https://doi.org/10.1016/j.vaccine.2010.01.042>
- 474 Douville, L. E., Myers, A., Jackson, M. A., & Lantos, J. D. (2010). Health care worker knowledge,
475 attitudes, and beliefs regarding mandatory influenza vaccination. *Archives of Pediatrics and*
476 *Adolescent Medicine*, 164(1), 33–37. <https://doi.org/10.1001/archpediatrics.2009.252>
- 477 Durando, P., Alicino, C., Dini, G., Barberis, I., Bagnasco, A. M., Iudici, R., Zanini, M., Martini, M.,
478 Toletone, A., Paganino, C., Massa, E., Orsi, A., & Sasso, L. (2016). Determinants of
479 adherence to seasonal influenza vaccination among healthcare workers from an Italian region:
480 Results from a cross-sectional study. *BMJ Open*, 6(5). [https://doi.org/10.1136/bmjopen-2015-](https://doi.org/10.1136/bmjopen-2015-010779)
481 [010779](https://doi.org/10.1136/bmjopen-2015-010779)
- 482 Elawad, K. H., Farag, E. A., Abuelgasim, D. A., Smatti, M. K., Al-Romaihi, H. E., Al Thani, M., Al
483 Mujalli, H., Shehata, Z., Alex, M., Al Thani, A. A., & Yassine, H. M. (2017). Improving
484 influenza vaccination rate among primary healthcareworkers in Qatar. *Vaccines*, 5(4).
485 <https://doi.org/10.3390/vaccines5040036>
- 486 Feemster, K. A., Prasad, P., Smith, M. J., Feudtner, C., Caplan, A., Offit, P., & Coffin, S. E. (2011).
487 Employee designation and health care worker support of an influenza vaccine mandate at a
488 large pediatric tertiary care hospital. *Vaccine*, 29(9), 1762–1769.
489 <https://doi.org/10.1016/j.vaccine.2010.12.115>
- 490 Ghandora, H., Halperin, D. M., Isenor, J. E., Taylor, B. A., Fullsack, P., Di Castri, A. M., &
491 Halperin, S. A. (2019). Knowledge, attitudes, behaviours, and beliefs of healthcare provider
492 students regarding mandatory influenza vaccination. *Human Vaccines and*
493 *Immunotherapeutics*, 15(3), 700–709. <https://doi.org/10.1080/21645515.2018.1543523>
- 494 Ghendon, Y. (1992). Influenza—Its impact and control. *World Health Statistics Quarterly*, 45(2–3),
495 306–311.
- 496 Gianfredi, V., Dallagiacoma, G., Provenzano, S., & Santangelo, O. E. (2019). Factors predicting
497 health science students' willingness to be vaccinated against seasonal flu during the next
498 campaign. *Annali Dell'Istituto Superiore Di Sanita*, 55(3), 209–216.
499 https://doi.org/10.4415/ANN_19_03_03
- 500 Gianino, M. M., Politano, G., Scarmozzino, A., Stillo, M., Amprino, V., Di Carlo, S., Benso, A., &
501 Zotti, C. M. (2019). Cost of Sickness Absenteeism during Seasonal Influenza Outbreaks of
502 Medium Intensity among Health Care Workers. *International Journal of Environmental*
503 *Research and Public Health*, 16(5). <https://doi.org/10.3390/ijerph16050747>
- 504 Goldstein, A. O., Kincade, J. E., Gamble, G., & Bearman, R. S. (2004). Policies and Practices for
505 Improving Influenza Immunization Rates Among Healthcare Workers. *Infection Control &*
506 *Hospital Epidemiology*, 25(11), 908–911. <https://doi.org/10.1086/502318>

- 507 Gualano, M. R., Bert, F., Voglino, G., Buttinelli, E., D'Errico, M. M., De Waure, C., Di Giovanni,
508 P., Fantini, M. P., Giuliani, A. R., Marranzano, M., Masanotti, G., Massimi, A., Nante, N.,
509 Pennino, F., Squeri, R., Stefanati, A., Signorelli, C., Siliquini, R., Castaldi, S., ... Zappalà, G.
510 (2018). Attitudes towards compulsory vaccination in Italy: Results from the NAVIDAD
511 multicentre study. *Vaccine*, 36(23), 3368–3374. <https://doi.org/10.1016/j.vaccine.2018.04.029>
- 512 Gualano, M. R., Olivero, E., Voglino, G., Corezzi, M., Rossello, P., Vicentini, C., Bert, F., &
513 Siliquini, R. (2019). Knowledge, attitudes and beliefs towards compulsory vaccination: A
514 systematic review. *Human Vaccines and Immunotherapeutics*, 15(4), 918–931.
515 <https://doi.org/10.1080/21645515.2018.1564437>
- 516 Hakim, H., Gaur, A. H., & McCullers, J. A. (2011). Motivating factors for high rates of influenza
517 vaccination among healthcare workers. *Vaccine*, 29(35), 5963–5969.
518 <https://doi.org/10.1016/j.vaccine.2011.06.041>
- 519 Halpin, C., & Reid, B. (2019). Attitudes and beliefs of healthcare workers about influenza
520 vaccination. *Nursing Older People*, 31(2). <https://doi.org/10.7748/nop.2019.e1154>
- 521 Haridi, H. K., Salman, K. A., Basaif, E. A., & Al-Skaibi, D. K. (2017). Influenza vaccine uptake,
522 determinants, motivators, and barriers of the vaccine receipt among healthcare workers in a
523 tertiary care hospital in Saudi Arabia. *Journal of Hospital Infection*, 96(3), 268–275.
524 <https://doi.org/10.1016/j.jhin.2017.02.005>
- 525 Higgins, J. P. T., Thompson, S. G., & Spiegelhalter, D. J. (2009). A re-evaluation of random-effects
526 meta-analysis. *Journal of the Royal Statistical Society. Series A: Statistics in Society*, 172(1),
527 137–159. <https://doi.org/10.1111/j.1467-985X.2008.00552.x>
- 528 Higgins JPT, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, W. V. (2019). Cochrane
529 Handbook for Systematic Reviews of Interventions. In Cochrane (Ed.), *Cochrane Handbook*
530 *for Systematic Reviews of Interventions* (6.0). <https://doi.org/10.1002/9781119536604>
- 531 Hollmeyer, H., Hayden, F., Mounts, A., & Buchholz, U. (2013). Review: Interventions to increase
532 influenza vaccination among healthcare workers in hospitals. *Influenza and Other Respiratory*
533 *Viruses*, 7(4), 604–621. <https://doi.org/10.1111/irv.12002>
- 534 Hubble, M. W., Zontek, T. L., & Richards, M. E. (2011). Predictors of influenza vaccination among
535 emergency medical services personnel. *Prehospital Emergency Care*, 15(2), 175–183.
536 <https://doi.org/10.3109/10903127.2010.541982>
- 537 Hudu, S. A., Harmal, N. S., Malina, O., & Sekawi, Z. (2016). Influenza vaccination among
538 Malaysian healthcare workers: A survey of coverage and attitudes. In *Medical Journal of*
539 *Malaysia* (No. 5; Vol. 71, pp. 231–237). <http://www.cdc.gov/flu/fluview/>
- 540 Hunter, J. P., Saratzis, A., Sutton, A. J., Boucher, R. H., Sayers, R. D., & Bown, M. J. (2014). In
541 meta-analyses of proportion studies, funnel plots were found to be an inaccurate method of
542 assessing publication bias. *Journal of Clinical Epidemiology*, 67(8), 897–903.
543 <https://doi.org/10.1016/j.jclinepi.2014.03.003>
- 544 Imai, C., Toizumi, M., Hall, L., Lambert, S., Halton, K., & Merollini, K. (2018). A systematic
545 review and meta-analysis of the direct epidemiological and economic effects of seasonal
546 influenza vaccination on healthcare workers. *PLoS ONE*, 13(6).
547 <https://doi.org/10.1371/journal.pone.0198685>

- 548 Isaacs, D., & Leask, J. (2008). Should influenza immunisation be mandatory for healthcare
549 workers? No. *BMJ (Clinical Research Ed.)*, 337. <https://doi.org/10.1136/bmj.a2140>
- 550 Jorgensen, P., Mereckiene, J., Cotter, S., Johansen, K., Tsoлова, S., & Brown, C. (2018). How close
551 are countries of the WHO European Region to achieving the goal of vaccinating 75% of key
552 risk groups against influenza? Results from national surveys on seasonal influenza vaccination
553 programmes, 2008/2009 to 2014/2015. *Vaccine*, 36(4), 442–452.
554 <https://doi.org/10.1016/j.vaccine.2017.12.019>
- 555 Karageorgou, K., Katerelos, P., Efstathiou, A., Theodoridou, M., & Maltezou, H. C. (2014).
556 Vaccination coverage and susceptibility against vaccine-preventable diseases of healthcare
557 students in Athens, Greece. *Vaccine*, 32(39), 5083–5086.
558 <https://doi.org/10.1016/j.vaccine.2014.06.031>
- 559 Kent, J. N., Lea, C. S., Fang, X., Novick, L. F., & Morgan, J. (2010). Seasonal Influenza
560 Vaccination Coverage Among Local Health Department Personnel in North Carolina, 2007-
561 2008. *American Journal of Preventive Medicine*, 39(1), 74–77.
562 <https://doi.org/10.1016/j.amepre.2010.03.007>
- 563 Krok-Schoen, J. L., Bernardo, B. M., Weier, R. C., Peng, J., Katz, M. L., Reiter, P. L., Richardson,
564 M. S., Pennell, M. L., Tatum, C. M., & Paskett, E. D. (2018). Belief About Mandatory School
565 Vaccinations and Vaccination Refusal Among Ohio Appalachian Parents: Do Demographic
566 and Religious Factors, General Health, and Political Affiliation Play a Role? *Journal of Rural*
567 *Health*, 34(3), 283–292. <https://doi.org/10.1111/jrh.12285>
- 568 Kyaw, W. M., Chow, A., Hein, A. A., Lee, L. T., Leo, Y. S., & Ho, H. J. (2019). Factors
569 influencing seasonal influenza vaccination uptake among health care workers in an adult
570 tertiary care hospital in Singapore: A cross-sectional survey. *American Journal of Infection*
571 *Control*, 47(2), 133–138. <https://doi.org/10.1016/j.ajic.2018.08.011>
- 572 La Torre, G., Scalingi, S., Garruto, V., Siclari, M., Chiarini, M., & Mannocci, A. (2017).
573 Knowledge, Attitude and Behaviours towards Recommended Vaccinations among Healthcare
574 Workers. *Healthcare*, 5(1), 13. <https://doi.org/10.3390/healthcare5010013>
- 575 LaVela, S. L., Etingen, B., & Miskevics, S. (2015). Attitudes toward influenza vaccination
576 improvement strategies in Veterans Affairs health care workers providing care for patients
577 with spinal cord injuries and disorders: Acceptability of a declination form program. *Vaccine*,
578 33(36), 4602–4609. <https://doi.org/10.1016/j.vaccine.2015.06.083>
- 579 Leask, J., Helms, C. M., Chow, M. Y., Robbins, S. C. C., & McIntyre, P. B. (2010). Making
580 influenza vaccination mandatory for health care workers: The views of NSW Health
581 administrators and clinical leaders. *New South Wales Public Health Bulletin*, 21(9–10), 243–
582 247. <https://doi.org/10.1071/nb10042>
- 583 Lester, R. T., McGeer, A., Tomlinson, G., & Detsky, A. S. (2003). Use of, Effectiveness of, and
584 Attitudes Regarding Influenza Vaccine Among House Staff. *Infection Control & Hospital*
585 *Epidemiology*, 24(11), 839–844. <https://doi.org/10.1086/502146>
- 586 Liberati, A., Altman, D. G., Tetzlaff, J., Mulrow, C., Gøtzsche, P. C., Ioannidis, J. P. A., Clarke,
587 M., Devereaux, P. J., Kleijnen, J., & Moher, D. (2009). The PRISMA statement for reporting
588 systematic reviews and meta-analyses of studies that evaluate health care interventions:

589 Explanation and elaboration. *PLoS Medicine*, 6(7), e1000100.
590 <https://doi.org/10.1371/journal.pmed.1000100>

591 Linam, W. M., Gilliam, C. H., Honeycutt, M., Wisdom, C., Swearingen, C. J., & Romero, J. R.
592 (2014). Parental perceptions about required influenza immunization of pediatric healthcare
593 personnel. *Infection Control and Hospital Epidemiology*, 35(10), 1301–1303.
594 <https://doi.org/10.1086/678061>

595 Little, K. E., Goodridge, S., Lewis, H., Lingard, S. W., Din, S., Tidley, M., Roberts, R. J., Williams,
596 N. S., & Hayes, S. (2015). Occupational vaccination of health care workers: Uptake, attitudes
597 and potential solutions. *Public Health*, 129(6), 755–762.
598 <https://doi.org/10.1016/j.puhe.2015.02.031>

599 Looper, P., George, D., Johnson, E. J., & Conway, S. E. (2017). Student and faculty perceptions
600 about mandatory influenza vaccinations on a health sciences campus. *Journal of American*
601 *College Health*, 65(7), 513–517. <https://doi.org/10.1080/07448481.2017.1341899>

602 Lorenc, T., Marshall, D., Wright, K., Sutcliffe, K., & Sowden, A. (2017). Seasonal influenza
603 vaccination of healthcare workers: Systematic review of qualitative evidence. *BMC Health*
604 *Services Research*, 17(1). <https://doi.org/10.1186/s12913-017-2703-4>

605 Lugo, N. R. (2007). Will carrots or sticks raise influenza immunization rates of health care
606 personnel? In *American Journal of Infection Control* (Vol. 35). Mosby Inc.
607 <https://doi.org/10.1016/j.ajic.2006.10.004>

608 MacDonald, N. E., Eskola, J., Liang, X., Chaudhuri, M., Dube, E., Gellin, B., Goldstein, S., Larson,
609 H., Manzo, M. L., Reingold, A., Tshering, K., Zhou, Y., Duclos, P., Guirguis, S., Hickler, B.,
610 & Schuster, M. (2015). Vaccine hesitancy: Definition, scope and determinants. *Vaccine*,
611 33(34), 4161–4164. <https://doi.org/10.1016/j.vaccine.2015.04.036>

612 Maltezou, H. C., Gargalianos, P., Nikolaidis, P., Katerelos, P., Tedoma, N., Maltezos, E., &
613 Lazanas, M. (2012). Attitudes towards mandatory vaccination and vaccination coverage
614 against vaccine-preventable diseases among health-care workers in tertiary-care hospitals.
615 *Journal of Infection*, 64(3), 319–324. <https://doi.org/10.1016/j.jinf.2011.12.004>

616 Maltezou, H. C., Katerelos, P., Poufta, S., Pavli, A., Maragos, A., & Theodoridou, M. (2013).
617 Attitudes toward mandatory occupational vaccinations and vaccination coverage against
618 vaccine-preventable diseases of health care workers in primary health care centers. *American*
619 *Journal of Infection Control*, 41(1), 66–70. <https://doi.org/10.1016/j.ajic.2012.01.028>

620 Maltezou, H. C., Lourida, A., Katragkou, A., Grivea, I. N., Katerelos, P., Wicker, S.,
621 Syrogiannopoulos, G. A., Roilides, E., & Theodoridou, M. (2012). Attitudes regarding
622 occupational vaccines and vaccination coverage against vaccine-preventable diseases among
623 healthcare workers working in pediatric departments in Greece. *Pediatric Infectious Disease*
624 *Journal*, 31(6), 623–625. <https://doi.org/10.1097/INF.0b013e31824ddc1e>

625 Maulik, P. K., Mascarenhas, M. N., Mathers, C. D., Dua, T., & Saxena, S. (2011). Prevalence of
626 intellectual disability: A meta-analysis of population-based studies. In *Research in*
627 *Developmental Disabilities* (Vol. 32). Res Dev Disabil.
628 <https://doi.org/10.1016/j.ridd.2010.12.018>

629 Maurer, J., Harris, K. M., Black, C. L., & Euler, G. L. (2012). Support for Seasonal Influenza
630 Vaccination Requirements among US Healthcare Personnel. *Infection Control & Hospital*
631 *Epidemiology*, 33(3), 213–221. <https://doi.org/10.1086/664056>

632 Naleway, A. L., Henkle, E. M., Ball, S., Bozeman, S., Gaglani, M. J., Kennedy, E. D., &
633 Thompson, M. G. (2014). Barriers and facilitators to influenza vaccination and vaccine
634 coverage in a cohort of health care personnel. *American Journal of Infection Control*, 42(4),
635 371–375. <https://doi.org/10.1016/j.ajic.2013.11.003>

636 Nicolay, N., Lévy-Bruhl, D., Gautier, A., Jestin, C., & Jauffret-Roustide, M. (2008). Mandatory
637 immunization: The point of view of the French general population and practitioners. *Vaccine*,
638 26(43), 5484–5493. <https://doi.org/10.1016/j.vaccine.2008.07.058>

639 Osterholm, M. T., Kelley, N. S., Sommer, A., & Belongia, E. A. (2012). Efficacy and effectiveness
640 of influenza vaccines: A systematic review and meta-analysis. *The Lancet Infectious Diseases*,
641 12(1), 36–44. [https://doi.org/10.1016/S1473-3099\(11\)70295-X](https://doi.org/10.1016/S1473-3099(11)70295-X)

642 Perkins, R. B., Pierre-Joseph, N., Marquez, C., Iloka, S., & Clark, J. A. (2010). Parents' opinions of
643 mandatory human papillomavirus vaccination: Does ethnicity matter? *Women's Health Issues*,
644 20(6), 420–426. <https://doi.org/10.1016/j.whi.2010.07.001>

645 Pichon, M., Gaymard, A., Zamolo, H., Bazire, C., Valette, M., Sarkozy, F., & Lina, B. (2019).
646 Web-based analysis of adherence to influenza vaccination among French healthcare workers.
647 *Journal of Clinical Virology*, 116, 29–33. <https://doi.org/10.1016/j.jcv.2019.04.008>

648 Pless, A., Shaw, D., McLennan, S., & Elger, B. S. (2017). Nurses' attitudes towards enforced
649 measures to increase influenza vaccination: A qualitative study. *Influenza and Other*
650 *Respiratory Viruses*, 11(3), 247–253. <https://doi.org/10.1111/irv.12441>

651 Poland, G. A., Ofstead, C. L., Tucker, S. J., & Beebe, T. J. (2008). Receptivity to Mandatory
652 Influenza Vaccination Policies for Healthcare Workers Among Registered Nurses Working on
653 Inpatient Units. *Infection Control & Hospital Epidemiology*, 29(2), 170–173.
654 <https://doi.org/10.1086/526432>

655 Polgreen, P. M., Septimus, E., Talbot, T. R., Beekmann, S. E., & Helms, C. (2010). Results of a
656 National Survey of Infectious Diseases Specialists regarding Influenza Vaccination Programs
657 for Healthcare Workers. *Infection Control & Hospital Epidemiology*, 31(10), 1063–1065.
658 <https://doi.org/10.1086/656382>

659 Potter, J., Stott, D. J., Roberts, M. A., Elder, A. G., O'Donnell, B., Knight, P. V., & Carman, W. F.
660 (1997). Influenza vaccination of health care workers in long-term-care hospitals reduces the
661 mortality of elderly patients. *Journal of Infectious Diseases*, 175(1), 1–6.
662 <https://doi.org/10.1093/infdis/175.1.1>

663 Quintyne, K. I., Daly, E., Brabazon, E., Finnegan, P., & Kavanagh, P. (2018). Attitudes and uptake
664 of seasonal Influenza Vaccination for Health Service Executive (HSE) Staff. *Irish Medical*
665 *Journal*, 111(5), 749.

666 R Core Team (2020). (n.d.). *R: A language and environment for statistical computing*. R
667 *Foundation for Statistical Computing*. <https://www.r-project.org/>

- 668 Rea, E., & Upshur, R. (2001). Semmelweis revisited: The ethics of infection prevention among
669 health care workers. In *CMAJ : Canadian Medical Association journal = journal de*
670 *l'Association médicale canadienne* (Vol. 164). Canadian Medical Association.
671 <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC81071/>
- 672 Rebmann, T., Wang, J., Wilson, K. D., Gilbertson, P. G., & Wakefield, M. (2016). Parents' and
673 staff's support for a childcare agency employee mandatory vaccination policy or agency
674 certification program. *American Journal of Infection Control*, 44(7), 799–804.
675 <https://doi.org/10.1016/j.ajic.2016.01.033>
- 676 Rebmann, T., Wright, K. S., Anthony, J., Knaup, R. C., & Peters, E. B. (2012a). Seasonal Influenza
677 Vaccine Compliance among Hospital-Based and Nonhospital-Based Healthcare Workers.
678 *Infection Control & Hospital Epidemiology*, 33(3), 243–249. <https://doi.org/10.1086/664057>
- 679 Rebmann, T., Wright, K. S., Anthony, J., Knaup, R. C., & Peters, E. B. (2012b). Seasonal and
680 H1N1 influenza vaccine compliance and intent to be vaccinated among emergency medical
681 services personnel. *American Journal of Infection Control*, 40(7), 632–636.
682 <https://doi.org/10.1016/j.ajic.2011.12.016>
- 683 Rivetti, D., Jefferson, T., Thomas, R. E., Rudin, M., Rivetti, A., Di Pietrantonj, C., & Demicheli, V.
684 (2006). Vaccines for preventing influenza in the elderly. In *Cochrane Database of Systematic*
685 *Reviews*. John Wiley & Sons, Ltd. <https://doi.org/10.1002/14651858.cd004876.pub2>
- 686 Saluja, I., Theakson, K. D., & Kaczorowski, J. (2005). Influenza vaccination rate among emergency
687 department personal: A survey of four teaching hospitals. In *Canadian Journal of Emergency*
688 *Medicine* (Vol. 7). Canadian Medical Association.
689 <https://doi.org/10.1017/s1481803500012884>
- 690 Sánchez, L., & García-Fragoso, L. (2013). Determinant factors for acceptance of seasonal influenza
691 vaccination among healthcare workers after the 2009 influenza-A (H1N1) pandemic in a
692 hospital at the metropolitan area of Puerto Rico. *Boletín de La Asociación Médica de Puerto*
693 *Rico*, 105(4), 20–24.
- 694 Schwarzer, G., Chemaitelly, H., Abu-Raddad, L. J., & Rücker, G. (2019). Seriously misleading
695 results using inverse of Freeman-Tukey double arcsine transformation in meta-analysis of
696 single proportions. *Research Synthesis Methods*, 10(3), 476–483.
697 <https://doi.org/10.1002/jrsm.1348>
- 698 Seale, H., Leask, J., & MacIntyre, C. R. (2011). Awareness, attitudes and behavior of hospital
699 healthcare workers towards a mandatory vaccination directive: Two years on. *Vaccine*, 29(21),
700 3734–3737. <https://doi.org/10.1016/j.vaccine.2011.03.050>
- 701 Shrikrishna, D., Williams, S., Restrict, L., & Hopkinson, N. S. (2015). Influenza vaccination for
702 NHS staff: Attitudes and uptake. *BMJ Open Respiratory Research*, 2(1), 1–4.
703 <https://doi.org/10.1136/bmjresp-2015-000079>
- 704 Stijnen, T., Hamza, T. H., & Özdemir, P. (2010). Random effects meta-analysis of event outcome in
705 the framework of the generalized linear mixed model with applications in sparse data.
706 *Statistics in Medicine*, 29(29), 3046–3067. <https://doi.org/10.1002/sim.4040>
- 707 Thompson, M. G., McIntyre, A. F., Naleway, A. L., Black, C., Kennedy, E. D., Ball, S., Walker, D.
708 K., Henkle, E. M., & Gaglani, M. J. (2013). Potential influence of seasonal influenza

- 709 vaccination requirement versus traditional vaccine promotion strategies on unvaccinated
710 healthcare personnel. *Vaccine*, 31(37), 3915–3921.
711 <https://doi.org/10.1016/j.vaccine.2013.06.045>
- 712 To, K. W., Lai, A., Lee, K. C. K., Koh, D., & Lee, S. S. (2016). Increasing the coverage of
713 influenza vaccination in healthcare workers: Review of challenges and solutions. In *Journal of*
714 *Hospital Infection* (Vol. 94). W.B. Saunders Ltd. <https://doi.org/10.1016/j.jhin.2016.07.003>
- 715 Veroniki, A. A., Jackson, D., Viechtbauer, W., Bender, R., Bowden, J., Knapp, G., Kuss, O.,
716 Higgins, J. P., Langan, D., & Salanti, G. (2016). Methods to estimate the between-study
717 variance and its uncertainty in meta-analysis. *Research Synthesis Methods*, 7(1), 55–79.
718 <https://doi.org/10.1002/jrsm.1164>
- 719 Viechtbauer, W. (2010). Conducting meta-analyses in R with the metafor. *Journal of Statistical*
720 *Software*, 36(3), 1–48.
- 721 Walker, L., Newall, A., & Heywood, A. E. (2016). Knowledge, attitudes and practices of Australian
722 medical students towards influenza vaccination. *Vaccine*, 34(50), 6193–6199.
723 <https://doi.org/10.1016/j.vaccine.2016.10.074>
- 724 *WHO fact sheet on influenza*. (n.d.). Retrieved September 25, 2020, from
725 [https://www.who.int/news-room/fact-sheets/detail/influenza-\(seasonal\)](https://www.who.int/news-room/fact-sheets/detail/influenza-(seasonal))
- 726 Wicker, S., Rabenau, H. F., Ackermann, H., Poland, G. A., & Marckmann, G. (2011). Rechtfertigt
727 der Patientenschutz verpflichtende Impfungen? Ergebnisse einer anonymen Befragung von
728 Medizinstudierenden. In *Deutsche Medizinische Wochenschrift* (Vol. 136). Dtsch Med
729 Wochenschr. <https://doi.org/10.1055/s-0031-1280551>
- 730 Wicker, Sabine, Marckmann, G., Poland, G. A., & Rabenau, H. F. (2010). Healthcare Workers’
731 Perceptions of Mandatory Vaccination: Results of an Anonymous Survey in a German
732 University Hospital. *Infection Control & Hospital Epidemiology*, 31(10), 1066–1069.
733 <https://doi.org/10.1086/656242>
- 734 Willis, B. C., & Wortley, P. (2007). Nurses’ attitudes and beliefs about influenza and the influenza
735 vaccine: A summary of focus groups in Alabama and Michigan. *American Journal of Infection*
736 *Control*, 35(1), 20–24. <https://doi.org/10.1016/j.ajic.2006.07.009>
- 737 Wu, F., Zhao, S., Yu, B., Chen, Y. M., Wang, W., Song, Z. G., Hu, Y., Tao, Z. W., Tian, J. H., Pei,
738 Y. Y., Yuan, M. L., Zhang, Y. L., Dai, F. H., Liu, Y., Wang, Q. M., Zheng, J. J., Xu, L.,
739 Holmes, E. C., & Zhang, Y. Z. (2020). A new coronavirus associated with human respiratory
740 disease in China. *Nature*, 579(7798), 265–269. <https://doi.org/10.1038/s41586-020-2008-3>
- 741 Yue, X., Black, C., Ball, S., Donahue, S., de Perio, M. A., Laney, A. S., & Greby, S. (2019).
742 Workplace Interventions and Vaccination-Related Attitudes Associated With Influenza
743 Vaccination Coverage Among Healthcare Personnel Working in Long-Term Care Facilities,
744 2015–2016 Influenza Season. *Journal of the American Medical Directors Association*, 20(6),
745 718–724. <https://doi.org/10.1016/j.jamda.2018.11.029>