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Mass media effect on vaccines uptake during silent polio outbreak

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ABSTRACT

Background: During 2013, isolation of a wild type 1 poliovirus from routine sewage sample in Israel, led to a national OPV campaign. During this period, there was a constant cover of the outbreak by the mass media.
Aims: To investigate the association of media exposure and OPV and non-OPV vaccines uptake during the 2013 silent polio outbreak in Israel.
Methods: We received data on daily immunization rates during the outbreak period from the Ministry of Health (MoH). We conducted a multivariable time trend analysis to assess the association between daily media exposure and vaccines uptake. Analysis was stratified by ethnicity and socio-economic status (SES).
Results: During the MoH supplemental immunization activity, 138,799 OPV vaccines were given. There was a significant association between media exposure and OPV uptake, most prominent in a lag of 3–5 days from the exposure among Jews (R.R 1.79C.I 95% 1.32–2.41) and high SES subgroups (R.R 1.71C.I 95% 1.27–2.30). These subgroups also showed increased non-OPV uptake in a lag of 3–5 days from the media exposure, in all vaccines except for MMR. Lower SES and non-Jewish subgroups did not demonstrate the same association.
Conclusion: Our findings expand the understanding of public behaviour during outbreaks. The public response shows high variability within specific subgroups. These findings highlight the importance of tailored communication strategies for each subgroup.

1. Background

The state of Israel was certified by the World Health Organization (WHO) as a polio free country in 2002. During April 2013, a wild poliovirus type 1 was isolated from routine sewage sample in Rahat and Be'er-Sheva, two cities in the Southern Region of Israel [1]. At the end of May 2013, the central virology laboratory identified the pathogen as a non-Sabin poliovirus type 1, which was isolated previously in Pakistan and Egypt [2]. Most of the isolations came from children below 10 years living in Bedouin Arab communities characterized with high IPV immunization rate (90–95%), but also with low socio-economic status and poor sanitation and overcrowded living conditions [3,4]. Not a single case of clinical polio infection was documented in Israel during the transmission period.

The Israel Ministry of Health (MoH) responded to the polio transmission with several actions, including the initiation of supplemental immunization with bOPV (bivalent oral polio vaccine) and the launching of a nationwide bOPV campaign throughout mass media channels [5–11]. By the end of the supplemental immunization activity, a coverage of 80–90% was reached in the Southern District where the outbreak begun among the high risk pediatric population.

The notion that media coverage can impact the public response during crisis was first described in the late 1950s [12]. This phenomenon can be attributed to the lack of information, atmosphere of risk and media tendency to focus on sensational stories which can alter health behaviour [13–15]. For instance, statins use was recently shown to be associated with negative media coverage of drug's potential adverse effects. [16,17].

The aim of this study was to investigate the association of media exposure and vaccines uptake during the 2013 polio silent outbreak in Southern Israel.

2. Methods

2.1. Clinical data sources

The study was approved by the Institutional Ethics Committee. The study population included all children under 10 years old (during 2013) in the Southern District of Israel who received at

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least one polio vaccine (any type) during the study period. We chose this group as they were the target population for the bOPV vaccination during the MoH supplemental immunization activity.

We obtained data on immunization rates from the MoH. This included the number of daily bOPV vaccines given during the supplemental immunization activities (August to October 2013). Additionally, we collected data on routine immunizations to investigate a possible "spillover effect" of the polio exposure on the media to other routine scheduled vaccines, such as the diphtheria-tetanus-pertussis-hemophilus influenza B-inactive polio (DTaP-Hib-IPV) vaccine, measles-mumps-rubella-varicella (MMRV), vaccine against pneumococcus bacteria (PCV) and against rotavirus (RVV) (June to October 2013). The latter period was chosen since after the supplemental immunization activities were initiated (August 2013), most of MoH resources were aimed at delivering bOPV even at the expense of the routine immunization plan. We retrieved demographic data from the Israeli MoH database including ethnicity of Jewish/non-Jewish communities and socio-economic status [18].

2.2. Mass media exposure

Media exposure was assessed by an Israeli commercial firm (Ifat) that maintains a database of all Israeli mass media publications, applying content analysis methodology to determine relevance of the publication to the present study, as has been reported elsewhere [19]. We searched television, radio, local and national newspapers and news websites (in Hebrew, Arabic, Russian and English) excluding blogs and forums, to identify relevant keywords for the polio silent outbreak. The cost of purchasing advertisement in national press in Israel directly reflects the public reach of the newspaper.

- For newspapers reports we measured the size of the report (in square inches) and multiplied it by the cost of purchasing a square inch in the same section of the publication.
- For broadcast reports, a similar measure was used: the length of the publication (in minutes) multiplied by the cost of each minute of advertisement during the same program/time of day.
- For internet reports, each page ranked according to the time of exposure, the location and the web trafficking.

These calculations, in addition to the dominant keywords in each report (full, partial, marginal and/or minimal) yielded an estimated value of advertising (EVA) for each report [20]. We referred to the mass media exposure as the daily EVA during study period. In addition, Qualitative content analysis was conducted in a sample of the entire polio reports, in order to determine specific media frames and their possible effect on public response. The media reports were analyzed to investigate how each item frames the efforts of the Israeli Ministry of Health (MoH) toward outbreak response, either through positive sentiment (e.g. regarding the great effort of the MoH) or negative sentiment (e.g. regarding vaccine adverse effect) [21].

Furthermore, to investigate the role of web exposure on vaccine uptake, we extracted data from Google Trends using the same keywords and time frame that were used in the main analysis. We conducted analysis using the same methods only with Google Trends search volume in the model instead of EVA in lags of several days from the exposure on the web.

2.3. Statistical methods

We used Generalized Linear Models (GLM) with unstructured correlation matrix and Poisson as a link function to model the daily vaccinations uptake. Each model was tested as a time series model, adjusted to seasonal variables. The models were tested for the entire cohort, and then separately for each layer (SES in deciles and Jews vs. Bedouins). The risk ratio and the 95% confidence interval were calculated for each variable. EVA was entered to each model after conducting a logarithmic (one scale) transformation to ensure normal distribution. Additionally, due to the longitude effect of media exposure on the public, we tested each model in lags of several days from the media exposure (in EVA) of the same day. The final models included variables selected upon statistical significance ($\alpha < 0.05$), the highest log-likelihood, model parsimony and clinical relevance. All analyses in this study were performed using IBM SPSS Statistics 24 for Windows [Armonk, NY: IBM Corp].

3. Results

During August to the end of October 2013, there were 138799 bOPV vaccines given in the Southern District of Israel. The number of weekly bOPV vaccines and media exposure is shown in Fig. 1, with close positive association that can be seen between media exposure and public compliance to the MoH mass media campaign. This association was shown to be significant in a lag of 3–5 days from the exposure in the entire cohort (R.R 2.02C.I 95% 1.39–2.92) among Jews (R.R 1.79C.I 95% 1.32–2.41) and high SES subgroups (R.R 1.71C.I 95% 1.27–2.30), Table 1.

Table 2 shows the association between media exposure and daily routine vaccines rates between June and early August 2013. During this period, 1240 DTaP-HIb-IPV, 1018 MMRV, 660 PCV and 636 RVV vaccines were given. Media exposure was associated with increased vaccine utilization mostly with a delay of 3–5 days from the media exposure, in all vaccines except for MMRV (negative effect with delay of 6–8 days which afterward diminished). The most prominent association was shown among Jews and high SES groups: R.R 1.33 (C.I 95% 1.06–1.67) within DTaP- HIb-IPV vaccine and R.R 1.36 (C.I 95% 1.08–1.71) within RVV vaccine for Jews and R.R 1.27 (C.I 95% 1.01–1.60) for high SES within PCV vaccine.

Table 3 shows the association between the media sentiment (positive vs. negative) and bOPV uptake. It appeared that only positive media exposure was associated with increased bOPV uptake, mostly in lags of 3–5 days from media exposure. Negative media exposure was not associated with change in vaccines uptake. Table 4 shows the association of OPV uptake with Google Trends search volume during the outbreak period. It appeared the similar to the results of the main analysis, the most prominent effect of Google search was during the first days and among higher socio-economic and Jewish populations. The effect diminished in more distant lags.

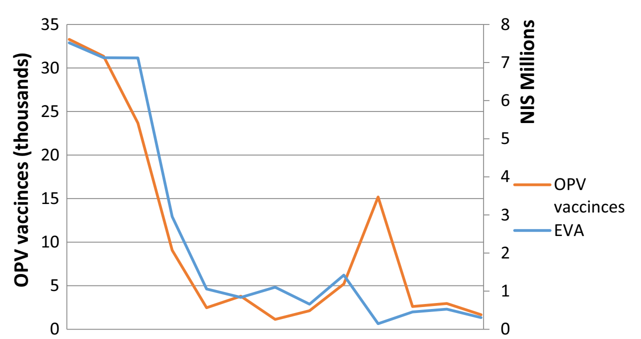

Fig. 1. Media exposure and weekly bOPV vaccines in Southern District of Israel (August-October 2013).

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Table 1
One scale log transformed EVA and daily bOPV in the southern region of Israel (August–October 2013)*.

	Lag 0		Lag 0–2		Lag 3–5		Lag 6–8	
	P value	R.R (95% CI)	P value	R.R (95% CI)	P value	R.R (95% CI)	P value	R.R (95% CI)
Total bOPV	0.251	0.848 (0.639–1.124)	0.604	1.115 (0.739–1.683)	<0.001	2.018 (1.394–2.919)	0.520	1.158 (0.741–1.809)
SES 1–4	0.190	0.818 (0.606–1.105)	0.932	0.981 (0.638–1.510)	0.050	1.544 (1.001–2.383)	0.908	1.027 (0.653–1.616)
SES 5–10	0.077	1.244 (0.977–1.583)	0.002	1.684 (1.213–2.338)	<0.001	1.709 (1.268–2.303)	0.816	0.959 (0.676–1.362)
Jewish	0.069	1.254 (0.982–1.602)	0.003	1.667 (1.195–2.325)	<0.001	1.788 (1.325–2.414)	0.682	0.930 (0.657–1.316)
Non Jewish	0.079	0.710 (0.485–1.040)	0.527	0.839 (0.488–1.444)	0.223	1.426 (0.806–2.524)	0.809	1.074 (0.601–1.921)

* Adjusted for weeks, weekends and holiday.
Abbreviations: EVA, estimated value of advertising; bOPV, bivalent oral polio vaccin; SES, socio economic status; CI, confidence interval.

Table 2
One scale log transformed EVA and daily routine vaccines in southern Israel in the early stage of polio sewage outbreak.

	LogEVA lag 0		LogEVA lag 0–2		LogEVA lag 3–5		LogEVA lag 6–8	
	P value	R.R (95% CI)	P value	R.R (95% CI)	P value	R.R (95% CI)	P value	R.R (95% CI)
DTaP IPV HIb								
All	0.356	0.943 (0.832–1.068)	0.528	0.929 (0.739–1.168)	0.023	1.307 (1.037–1.646)	0.210	0.851 (0.662–1.095)
Jewish	0.361	0.944 (0.833–1.069)	0.447	0.914 (0.726–1.152)	0.013	1.332 (1.061–1.671)	0.122	0.935 (0.859–1.018)
Non Jewish	0.399	0.937 (0.804–1.091)	0.795	0.966 (0.743–1.256)	0.159	1.227 (0.923–1.631)	0.105	1.089 (0.983–1.206)
SES 1–4	0.365	0.943 (0.831–1.071)	0.434	0.911 (0.723–1.150	0.024	1.312 (1.036–1.662)	0.389	0.963 (0.884–1.049)
SES 5–10	0.393	0.943 (0.824–1.079)	0.778	0.966 (0.757–1.232)	0.041	1.296 (1.011–1.661)	0.597	0.976 (0.892–1.068)
MMRV								
Total	0.205	0.930 (0.831–1.041)	0.330	0.907 (0.745–1.104)	0.886	0.982 (0.771–1.252)	0.040	0.780 (0.615–0.989)
Jewish	0.264	0.937 (0.837–1.050)	0.482	0.932 (0.767–1.133)	0.874	0.981 (0.769–1.250)	0.039	0.783 (0.620–0.988)
Non Jewish	0.149	0.902 (0.784–1.038)	0.098	0.816 (0.642–1.038)	0.960	0.993 (0.742–1.328)	0.079	0.769 (0.574–1.031)
SES 1–4	0.178	0.921 (0.817–1.038)	0.290	0.893 (0.724–1.101)	0.937	0.990 (0.770–1.273)	0.140	0.822 (0.634–1.066)
SES 5–10	0.436	0.951 (0.838–1.079)	0.578	0.940 (0.758–1.167)	0.819	0.967 (0.726–1.288)	0.004	0.687 (0.534–0.884)
Prevenar								
Total	0.762	0.981 (0.870–1.107)	0.453	0.923 (0.749–1.138)	0.129	1.194 (0.950–1.502)	0.218	0.863 (0.682–1.091)
Jewish	0.760	0.981 (0.870–1.107)	0.251	0.883 (0.714–1.092)	0.076	1.225 (0.979–1.533)	0.130	0.838 (0.667–1.054)
Non Jewish	0.837	0.984 (0.841–1.151)	0.683	1.053 (0.822–1.350)	0.576	1.087 (0.812–1.453)	0.779	0.958 (0.709–1.294)
SES 1–4	0.890	0.991 (0.872–1.126)	0.493	0.926 (0.744–1.153)	0.244	1.158 (0.904–1.483)	0.534	0.923 (0.718–1.187)
SES 5–10	0.554	0.961 (0.844–1.096)	0.446	0.915 (0.728–1.150)	0.046	1.269 (1.004–1.604)	0.018	0.747 (0.586–0.952)
Rota								
Total	0.152	0.916 (0.813–1.033)	0.177	0.858 (0.687–1.071)	0.009	1.354 (1.080–1.699)	0.153	0.830 (0.642–1.072)
Jewish	0.195	0.924 (0.819–1.041)	0.103	0.827 (0.659–1.039)	0.007	1.362 (1.087–1.707)	0.109	0.811 (0.629–1.047)
Non Jewish	0.147	0.892 (0.764–1.041)	0.717	0.953 (0.736–1.235)	0.055	1.314 (0.995–1.735)	0.511	0.901 (0.659–1.231)
SES 1–4	0.177	0.918 (0.812–1.039)	0.207	0.865 (0.689–1.084)	0.010	1.360 (1.076–1.719)	0.203	0.843 (0.648–1.097)
SES 5–10	0.160	0.912 (0.803–1.037)	0.167	0.846 (0.667–1.072)	0.016	1.344 (1.056–1.710)	0.111	0.805 (0.616–1.051)

*Adjusted for days, weeks and month.
Abbreviation: EVA - estimated value of advertising, DTaP-Hib-IPV - diphtheria-tetanus-pertussis-hemophilus influenza B-inactive polio, MMRV - measles-mumps-rubella-varicella, SES - socio economic status, CI - confidence interval.

Table 3
One scale log transformed EVA stratified by media sentiment and daily bOPV in the southern region of Israel (August-October 2013).

	Lag 0–2		Lag 3–5		Lag 6–8	
	P value	R.R (95% CI)	P value	R.R (95% CI)	P value	R.R (95% CI)
Positive						
Total bOPV	0.12	1.68 (0.87–3.27)	<0.001	3.35 (1.73–6.51)	0.02	2.92 (1.22–6.98)
SES 1–4	0.40	1.46 (0.60–3.54)	0.04	2.51 (1.05–6.02)	0.02	3.26 (1.22–8.72)
SES 5–10	0.03	2.05 (1.07–3.93)	0.08	1.85 (0.93–3.69)	0.19	1.79 (0.74–4.33)
Jewish	0.03	2.06 (1.06–3.98)	0.06	1.93 (0.97–3.84)	0.17	1.86 (0.77–4.49)
Non Jewish	0.67	1.30 (0.38–4.43)	0.12	2.99 (0.75–11.9)	0.03	4.33 (1.14–16.34)
Negative						
Total bOPV	0.65	0.89 (0.54–1.45)	0.43	1.31 (0.65–2.62)	0.18	0.67 (0.37–1.20)
SES 1–4	0.39	0.75 (0.40–1.42)	0.17	1.71 (0.79–3.70)	0.70	0.86 (0.40–1.86)
SES 5–10	0.58	1.13 (0.72–1.77)	0.93	0.97 (0.54–1.76)	0.01	0.46 (0.27–0.78)
Jewish	0.51	1.16 (0.73–1.85)	0.83	0.93 (0.51–1.70)	0.01	0.47 (0.27–0.82)
Non Jewish	0.18	0.57 (0.25–1.30)	0.09	2.34 (0.88–6.19)	0.74	1.19 (0.40–3.55)

*Adjusted for weeks, months, weekends and holiday.
Abbreviation: EVA – estimated value of advertising, bOPV – bivalent oral polio vaccine, SES – socio economic status, CI – confidence interval.

Table 4
Google trends volume search and daily bOPV in the southern region of Israel (August–October 2013).

	Lag 0		Lag 0–2		Lag 3–5		Lag 6–8	
	P value	R.R (95% CI)	P value	R.R (95% CI)	P value	R.R (95% CI)	P value	R.R (95% CI)
Total bOPV	0.429	1.002 (0.996–1.009)	0.782	1.001 (0.993–1.009)	0.890	1.001 (0.993–1.008)	0.411	0.996 (0.986–1.006)
SES 1–4	0.500	0.998 (0.991–1.004)	0.138	0.994 (0.986–1.002)	0.132	0.994 (0.986–1.002)	0.091	0.992 (0.982–1.001)
SES 5–10	<0.001	1.008 (1.004–1.012)	<0.001	1.012 (1.007–1.016)	<0.001	1.009 (1.004–1.014)	0.734	1.001 (0.995–1.008)
Jewish	<0.001	1.008 (1.004–1.012)	<0.001	1.012 (1.007–1.016)	<0.0011	1.009 (1.005–1.014)	0.727	1.001 (0.995–1.008)
Non Jewish	0.135	0.993 (0.983–1.002)	0.012	0.986 (0.974–0.997)	0.019	0.986 (0.975–0.998)	0.056	0.986 (0.972–1.000)

*Adjusted for weeks, weekends and holiday.
Abbreviation: bOPV – bivalent oral polio vaccine, SES – socio economic status, CI – confidence interval.

4. Discussion

The present study shows the impact of media exposure on the use of vaccinations during outbreak. We demonstrated the association of quantified media exposure (by EVA) and both bOPV vaccines during polio mass media campaign in addition to the routine vaccinations, as observed in a change of their utilization which followed the media exposure consistently. We showed that increased bOPV uptake was associated with media exposure mostly among Jews and higher SES individuals. In addition, we showed variable change among non-bOPV routine vaccines uptake.

Media exposure may influence the public behaviour specifically during infectious diseases outbreaks. For instance, the use of hygiene preventive measurements was positively related to H1N1 coverage during the 2009–2010 outbreak [22]. The timing of the exposure is also crucial to create the desirable effect on public health. As our results suggest, the most prominent effect was seen several days after media exposure. The importance of the timing of media exposure was previously reported during the H1N1 outbreak in Europe, as media attention was declined before the epidemic reached its peak, resulting in a decrease in H1N1 vaccines uptake and eventually more deaths in the second wave of the outbreak, where effective vaccine was in reach [23]. However, our study innovates by showing the impact of the media exposure in a daily resolution on the public behaviour.

In addition to the timing of media exposure, the selection of the risk communication strategy is crucial for the success of the vaccination activities. Vaccines uptake during the 2009–2010 H1N1 outbreak were higher when the media framing were more transparent and put responsibility on the general public itself [24]. In the 2013 silent polio outbreak, the challenge was even more complex. The MoH supplemental immunization activities took place in special circumstances where virus transmission occurred without a single case of clinical infection. The MoH efforts were made to increase bOPV uptake only among the 1–10 years old children, a population characterized with relatively high routine immunization rate, to prevent viral transmission. To cope with the communication challenges of "marketing" the public a live vaccine which was withdrawn from the Israeli immunization schedule in 2004, a special media response team was formed by the Israeli MoH in the early stages of 2013 silent polio outbreak [25]. Our finding suggest that by facilitating risk communication strategy which fitted public needs during the polio outbreak, the Israeli MoH managed to optimize the utilization of health resources (bOPV uptake) during the crisis in a well-planned and public oriented manner.

During the polio crisis, it emerged that bOPV uptake and some of non-bOPV vaccines among Bedouin and lower SES were not associated with media exposure (as opposed to the Jews and higher SES population). During routine ("non crisis") periods, it is unclear whether SES is associated with the uptake of scheduled immunization [26–29]. However, during disease outbreaks it emerged that high SES groups tend to implement effective preventive measures at a higher rate than lower SES [30,31]. This was explained by lower barriers to information access and consequently more knowledge attained among higher SES groups, which proved to be associated positively with the adoption of recommended prevention measures and negatively with the adoption of incorrect protective behaviours [32,33].

In the case of the polio transmission, we showed that the lower SES and Bedouin populations had weaker association (though still significant) between media exposure and bOPV uptake compared to Jews and higher SES groups. In a study that explored the effect of SES on bOPV uptake during this crisis, it was reported that while the coverage of bOPV was higher among the Arab population compared to Jews (92.4% vs. 59.2%), there was an inverse correlation between SES and compliance to bOPV in the Jewish population compared to a linear correlation in the Arab population [34]. The authors gave two possible explanations for this discrepancy: the enormous efforts the MoH dedicated to the Arab community during the campaign due to high incidence of polio isolations in this population, and cultural differences as oriental (including Arab) societies tend to prefer collective interests, compared to Western societies that prefer the interest of the individual. Interestingly, due to the weaker media/OPV association among Arabs that we found, it appears that there might be additional explanations for this finding. It has been proposed that lower SES groups showed also lower health literacy, which could exacerbate non-effective communication and undesirable health behaviour adaption among these groups [35]. Moreover, infectious disease outbreak risk communication has distinct and specific needs, such as building an equal partnership between the governmental agents and the public, engaging two-way communication with the public and maintaining public trust despite [36]. These measures have to be taken despite the uncertainty which accompanied outbreaks. Lower SES communities are less trustworthy of the official government channels, and rely more on traditional communication channels (face-to-face, local community and religious leaders. Hence, the MoH mass media campaign (which also included face-to-face contacts with local Bedouin leaders) could have had its impact regardless of the use of "classical media" channels [37]. The adoption of an ecological holistic strategy by the MoH, which included involvement of local stakeholders and trusted local leaders specifically within the Arab communities, may have contributed to the impact of the MoH mass media campaign in this population, and proved its superiority over the classical media form that we investigated in this research [25,38,39].

We acknowledge several data related limitations in our research. First, this study is of an observational retrospective nature and cannot establish causality between media exposure and use of health resources. Second, data extraction in this study was from the MoH bureau, and we could not retrieve additional demographic data (e.g., age and gender) or medical data (e.g., medical history) which could be possible confounders. Third, due to the ecological nature of study, we could not obtain the reason for vaccines uptake. Nonetheless, gaining significant associations of media exposure and vaccines uptake using "raw" data could only be enhanced on a more focused dataset. Fourth, we did not include social media analysis, which could influence and alter the assessment of the public response in the current era. The use of social media in health promotion increases the availability and the sharing of information, the accessibility of tailored information, it adds peer support, enhances authorities awareness of public opinions and may assist policymakers [40,41]. Yet, when we analyzed Google Trends search results we showed similar effect on vaccine uptake in the same lag from exposure, which further support the finding of our primary analysis. Lastly, the data of this research were gathered only from the Israeli MoH Southern District. It is worth mentioned that the bOPV coverage reached almost 100% in the Southern Bedouin communities, compared to the national average of nearly 80% [5]. These results emphasize the importance of analyzing the media effect specifically in the Southern District of Israel, where the MoH invested most of his effort during the supplemental immunization activities.

5. Conclusion

We showed a significant association between media exposure and the uptake of both bOPV and non-bOPV vaccines, which remained significant in a time trend analysis. Moreover, we showed that vaccines uptake is influenced by both ethnical and socio-economical factors. Our findings suggest that governmental agencies ought to select a tailored communication strategy to each risk, and to engage each community in a bottomed up fashion according to its needs to ensure high immunization coverage.

Conflict of interest

All authors declare no conflict of interests.

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